ATLAS of Nearctic shorebirds on the coast of South America

Environment Canada
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Volume 1

R.I.G. Morrison and
R.K. Ross

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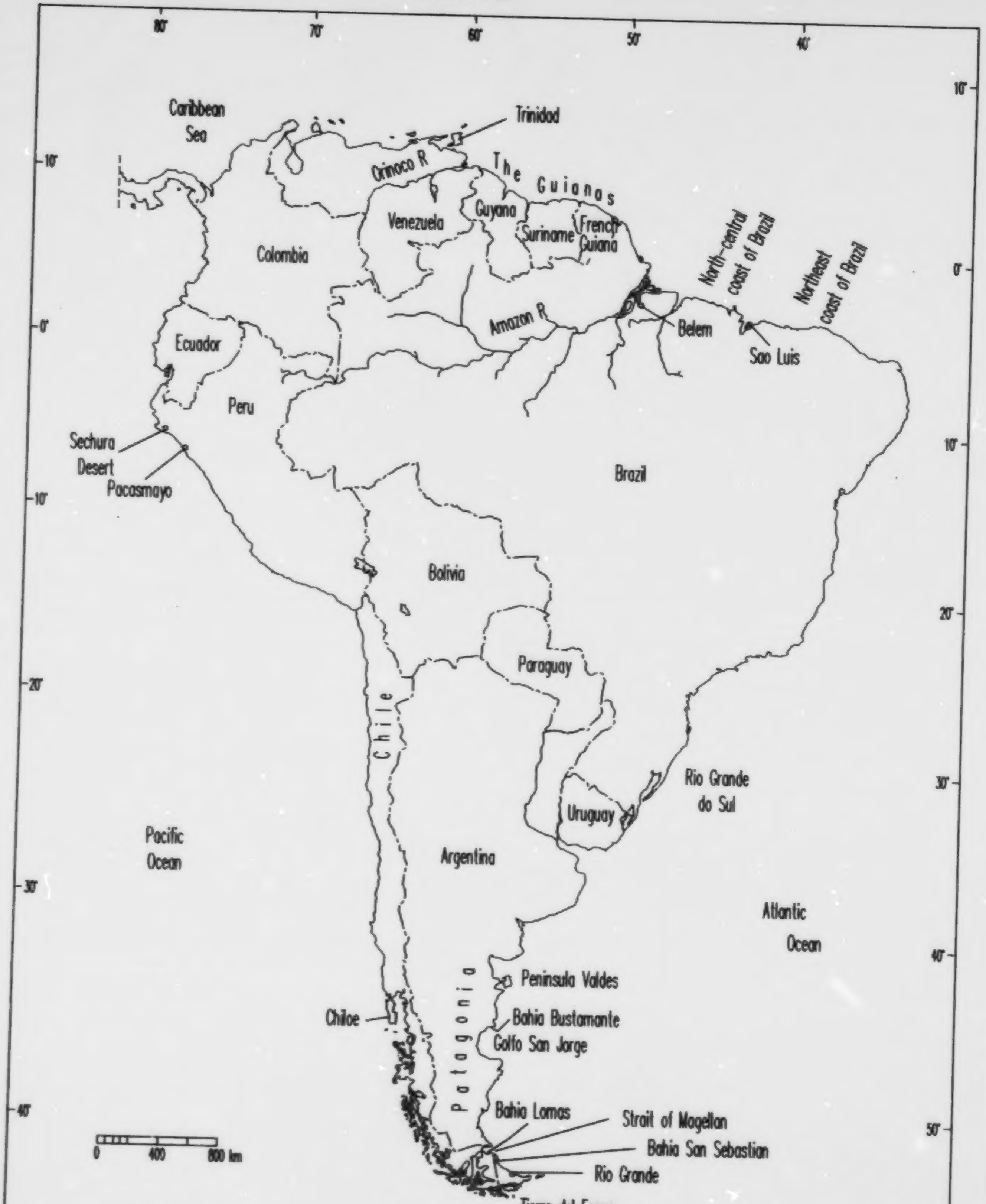
Locations of major wintering areas of Nearctic shorebirds referred to in the Atlas


80°
70°
60°
50°
40°
10°
Caribbean Sea
Trinidad
10°
Orinoco R
The Guianas
Guyana
Venezuela
Suriname
French Guiana
Colombia
North-central coast of Brazil
Northeast coast of Brazil
0°
0°
Ecuador
Amazon R
Belem
Sao Luis
Peru
Sechura Desert
Pacasmayo
10°
Brazil
10°
Bolivia
20°
Paraguay
20°
Chile
Rio Grande do Sul
30°
Uruguay
Pacific Ocean
Argentina
30°
Atlantic Ocean
40°
Peninsula Valdes
Patagonia
Chiloe
Bahia Bustamante
Golfo San Jorge
40°
Bahia Lomas
Strait of Magellan
50°
Bahia San Sebastian
0
400
800 km
Rio Grande
Tierra del Fuego
100°
90°
80°
70°
60°
50°
40°
30°

Atlas of Nearctic shorebirds on the coast of South America

in two volumes

Volume 1

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Abstract

This Atlas presents the results of aerial surveys undertaken to determine the principal wintering areas used by Nearctic shorebirds on the coast of South America. The surveys, carried out in January/February from 1982 to 1986, covered some 28 000 km of the South American coastline and included nearly all parts of the coast thought to contain significant habitat for shorebirds.

More than 2.9 million shorebirds were counted during the surveys, with small, medium-sized, and large species making up 80, 16, and 4% of the total, respectively. The surveys clearly identified the most important coastal wintering areas used by various categories and species of shorebirds. Many species concentrate to a remarkable degree on their wintering areas, so that a relatively small number of sites supports major portions of the censused population.

How to use the Atlas

This Atlas consists of two volumes. Volume 1 (Chapter 1–5) contains the Introduction (Chapter 1), Methods (Chapter 2), and Overview (Chapter 3), which summarizes the distribution of shorebirds on the coast of South America on a continental level. The Overview is presented in English, French, Spanish, and Portuguese. Chapter 4 discusses shorebird distribution in relation to geomorphology and environmental conditions, and Chapter 5 reviews the need for international cooperation in the conservation of shorebirds, citing the Western Hemisphere Shorebird Reserve Network as an example of a major conservation initiative that has arisen from internationally coordinated distributional studies.

Volume 2 (Chapters 6–15) gives detailed information on shorebird distribution in South America country by country, proceeding clockwise around the continent. Data for each survey sector are summarized by size category on the maps, to enable ready identification of areas supporting large concentrations of birds. Details of the species observed appear in tables facing the maps.

For distributional analysis on a broad geographical scale, survey sectors are grouped first into eco-units, which are areas of broadly similar habitats, and then into three major regions: North Coast, Atlantic Coast, and Pacific Coast (indicated by capitalization in the text). Each of the chapters devoted to shorebird distribution in a single country is intended to stand as an independent unit, but for ease of reference a brief summary of survey results from the continental perspective is included at the beginning of Volume 2 in English, French, Spanish, and Portuguese.

An index to all maps follows the Table of Contents in both volumes. Shorebird abundance in each survey sector on the maps is shown by circles representing different size categories of shorebirds: small (S), medium-sized (M), and large (L). The circles are always arranged in the order S–M–L, with the S circle closest to the coastline. At least one set of circles on each map is labelled so that this convention is clear.

Résumé

Le présent Atlas illustre les résultats de relevés aériens menés afin de nous permettre de déterminer les principales «aires d'hivernage» sur les côtes de l'Amérique du Sud des oiseaux de rivage de la région néarctique. Les relevés, qui ont été effectués durant les mois de janvier et février entre 1982 et 1986, ont permis de couvrir environ 28 000 km de rivage en Amérique du Sud, notamment toutes les parties de la côte dont on estimait qu'elles constituaient un habitat important pour les oiseaux de rivage.

Plus de 2,9 millions d'oiseaux de rivage de la région néarctique ont été dénombrés au cours de ces relevés; les petites, moyennes et grosses espèces constituaient 80 %, 16 % et 4 % du total, respectivement. Les relevés ont nettement permis d'établir quelles sont les principales aires d'hivernage côtières occupées par les différentes catégories et espèces d'oiseaux de rivage. Ces relevés ont permis d'établir que les populations d'oiseaux de rivage qui hivernent dans les secteurs côtiers de l'Amérique du Sud sont concentrées dans des secteurs restreints de l'aire de distribution, souvent avec des regroupements importants dans un nombre limité d'endroits.

Organisation de l'Atlas

L'Atlas est formé de deux volumes. Le volume 1 (chapitres 1–5) comprend l'Introduction (Chapitre 1), une section intitulée Methods (Chapitre 2) et une autre intitulée Overview (Chapitre 3), qui fournit un aperçu de la distribution des oiseaux de rivage néarctiques sur les côtes de l'Amérique du Sud. Cette dernière section est présentée en anglais, en français, en espagnol et en portugais. Le chapitre 4 traite de cette question par rapport aux conditions géomorphologiques et environnementales existantes et le chapitre 5 traite de la nécessité d'une collaboration internationale, telle qu'illustrée par la création du Réseau de réserves pour les oiseaux de rivage dans l'hémisphère occidental, une initiative d'envergure qui est le fruit de l'intégration à l'échelle internationale de diverses études de distribution.

Le volume 2 (chapitres 6–15) fournit une description détaillée de la distribution des oiseaux de rivage néarctiques dans chaque pays de l'Amérique du Sud et ce, au moyen d'un survol du continent effectué dans le sens des aiguilles de la montre. Les données pour chaque secteur de dénombrement sont résumées sur des cartes par catégorie de taille, de façon à permettre l'identification rapide des régions qui regroupent les grandes concentrations d'oiseaux. Les précisions sur les groupes d'espèces observés figurent sur des tableaux accompagnant chaque carte. Aux fins

d'une analyse de distribution géographique élargie, les secteurs de dénombrement sont groupés en éco-unités, ou régions formées d'habitats généralement identiques, elles-mêmes regroupées en trois régions principales : côte nord, côte Atlantique et côte Pacifique. (Dans le corps du texte anglais, l'emploi de la majuscule initiale permet de distinguer chaque région de la côte elle-même.) Chaque chapitre, conçu de façon à limiter l'analyse de la distribution à un seul pays, peut être consulté séparément. Le lecteur trouvera enfin en introduction au volume 2 un sommaire des résultats de dénombrements, présentés dans la perspective globale du continent et publié en anglais, en français, en espagnol et en portugais.

La liste des cartes suit la Table des matières dans l'un et l'autre volume. L'abondance des oiseaux de rivage dans chaque secteur de dénombrement est indiquée au moyen de cercles de grandeur diverse représentant chacune des trois catégories de taille d'oiseau : petite (S), moyenne (M), et grande (L). Ces cercles figurent toujours dans l'ordre susmentionné, le cercle (S) étant immédiatement adjacent au tracé des côtes. Sur chaque carte, au moins un jeu de cercles est toujours codé de façon à éviter toute confusion.

Resumen

Este Atlas presenta los resultados de la evaluación aérea realizada para determinar las principales "áreas de invernada" usadas por las aves de orilla marina del Neártico, en las costas de América del Sur. La evaluación se realizó en los meses de enero y febrero, entre 1982 y 1986, cubriendo alrededor de 28,000 km de líneas costeras de América del Sur, incluyendo hábitats de importante significado para aves de orilla marina.

Durante la evaluación, fueron contados mas de 2.9 millones de aves de orilla marina, de especies de tamaño pequeño, medio y grande, con 80%, 16% y 4% del total, respectivamente. La evaluación identificó claramente las áreas de invernada más importantes de la costa usadas por varias categorías y especies de aves de orilla marina. La evaluación ha demostrado que las poblaciones de aves de orilla, que invernan en las costas de América del Sur, están concentradas y restringidas aparte de este rango, con porcentajes substanciales que ocurren frecuentemente en un limitado número de sitios.

Organización del Atlas

Este Atlas se compone de dos volúmenes. El Volumen 1 (Capítulos 1-5) contiene la Introducción (Capítulo 1), Métodos (Capítulo 2), e Sobrevuelo (Capítulo 3), en que se resume la distribución de las aves de orilla marina en América del Sur, a nivel continental. El sobrevuelo de la distribución continental se presenta en inglés, francés, español y portugués. El Capítulo 4 se analiza la distribución de las aves de orilla marina en relación con la geomorfología y las condiciones ambientales, y el Capítulo 5 se estudia la necesidad de cooperación internacional para la conservación de las aves de orilla marina, poniendo a la Red Hemisférica de Reservas de Aves Playeras como ejemplo de importante iniciativa de conservación, surgida de estudios internacionalmente coordinados de distribución.

El Volumen 2 (Capítulos 6-15) proporciona información detallada sobre la distribución de las aves de orilla marina en América del Sur, país por país, analizándose los diferentes países de ese sub-continente siguiendo la dirección de las manecillas del reloj. En los mapas se resumen los datos correspondientes a cada sector del estudio por categoría de tamaño, lo que permite la fácil identificación de las áreas donde hay grandes concentraciones de aves. En las tablas que aparecen enfrente de los mapas se dan detalles de las especies observadas.

Para el análisis de distribución en una escala geográfica amplia, los sectores estudiados se agrupan primero en eco-unidades, que son aquellas áreas que tienen habitats similares, en términos generales, y posteriormente en tres regiones principales: costa norte, costa del Atlántico y costa del Pacífico (lo que se indica en el texto inglés empleando mayúsculas). Cada uno de los capítulos dedicados a la distribución de aves de orilla marina en un solo país constituye una unidad independiente, pero para facilitar el trabajo de referencia, a comienzos del Volumen 2 se incluye en inglés, francés, español y portugués un breve sumario de los resultados del estudio desde una perspectiva continental.

El índice de mapas sigue al Indice de cada volumen. La abundancia de aves de orilla marina en cada sector estudiado se indica en los mapas mediante círculos cuyo diámetro refleja la concentración de aves de orilla marina: pequeño (S), mediano (M) y grande (L). Los círculos aparecen siempre en el orden S-M-L, siendo siempre el círculo S mayúscula el más cercano a la costa. En cada mapa se rotula, por lo menos, un juego de círculos para evitar la confusion.

Resumo

O Atlas apresenta os resultados obtidos durante sobrevôos da costa da América do Sul, em busca das principais áreas de invernada de Charadriidae e Scolopacidae neárticos no litoral do continente. Realizados em janeiro e fevereiro de 1982 e 1986, os sobrevôos cobriram 28.000 km da costa sulamericana e incluiram áreas conhecidas do litoral com habitat para essas aves migratórias.

Mais de 2,9 milhões de maçaricos e batuíras das duas famílias foram contados durante os censos, subdivididos pelo porte em espécies grandes (4% do total), médias (16%) e pequenas (80%). Os censos identificaram claramente as principais áreas de invernada costeiras usadas pelas várias espécies e/ou categorias de tamanho de maçaricos. Os sobrevôos demonstraram que as populações de Scolopacidae e Charadriidae neárticas usando a costa sulamericana durante o inverno boreal estão concentradas em porções do continente, com altas porcentagens em um pequeno número de locais.

Composição do Atlas

O presente Atlas compõe-se de dois volumes. O volume 1, que contém os capítulos 1 a 5: Introdução (Capítulo 1), Métodos (Capítulo 2) e Apanhado geral (Capítulo 3). O capítulo 3 sumariza a distribuição das aves litorâneas no litoral da América do Sul à escala continental. O apanhado aparece redigido em inglês, francês, espanhol e português. O capítulo 4 analisa a distribuição das aves litorâneas, em função da geomorfologia e das condições ambientais. O capítulo 5 examina a necessidade de cooperação internacional no tocante à conservação das aves litorâneas, citando o ''Western Hemisphere Shorebird Reserve Network'' como um exemplo de initiativa de conservação, surgida de estudos de distribuição internacionalmente coordenados.

O volume 2, que contém os capítulos 6 a 15, fornece pormenorizadas informações sobre a distribuição das aves litorâneas na América do Sul, ordenadas seqüencialmente por país, em sentido circular da direita para a esquerda em torno do continente. Os dados referentes a cada setor sondado são resumidos em mapas, por categorias de tamanho, a fim de permitir a rápida identificação das áreas que sustentam grandes concentrações de aves. Os quadros contrapostos aos mapas fornecem detalhes sobre as espécies observadas.

Para permitir uma análise em grande escala da distribuição geográfica, os setores de sondagem são, primeiramente, agrupados em eco-unidades, que são áreas de *habitats* geralmente similares, e, seguidamente, consolidados em três regiões principais, a saber: costa do Norte, costa do Atlântico e costa do Pacífico (indicadas a letra maiúscula no texto inglês). Cada um dos capítulos dedicados à distribuição das aves litorâneas em determinado país é válido como unidade independente; contudo, para facilidade de consulta, fornece-se no começo do volume 2 um breve sumário dos resultados das sondagens, em inglês, francês, espanhol e português, sob um prisma continental.

Um índice de todos os mapas segue o índice geral de cada volume. A abundância das aves litorâneas em cada setor de sondagem focado nos mapas está indicado por círculos representativos das aves litorâneas de diferentes categorias de tamanho: pequeno (S), médio (M) e grande (L). Os círculos estão dispostos sempre na ordem ''S-M-L,'' com o círculo ''S'' mais próximo ao litoral. Cada mapa contém pelo menos um jogo de círculos rotulado para evitar a confusão.

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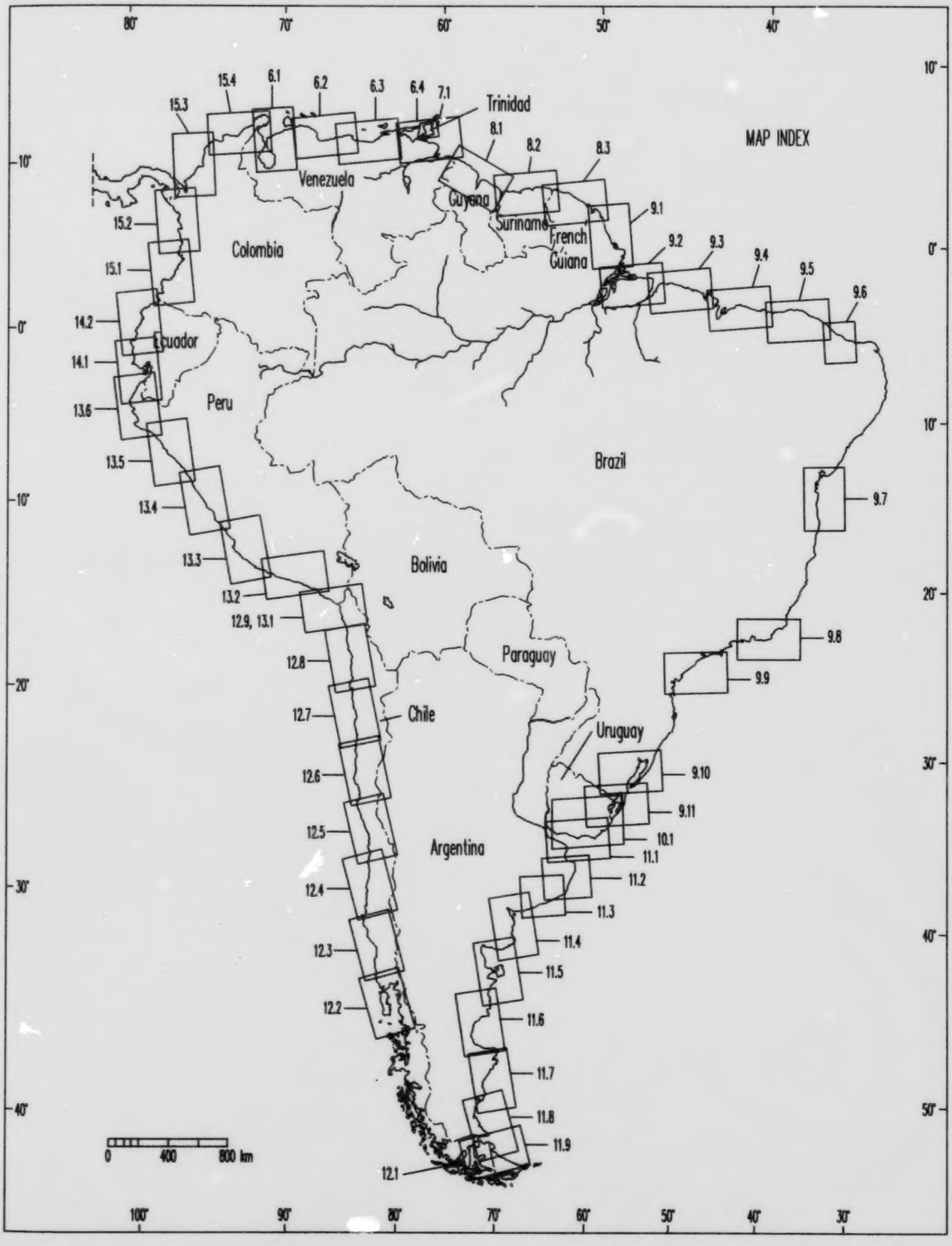
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Chapter 1

Introduction

R.I.G. Morrison

1.1. The South American Shorebird Atlas Project

Shorebirds not only comprise a major group of migratory birds in the Canadian avifauna, but also are one of the most important groups to be shared between the North and South American continents. Some 27 species of shorebirds that breed in Canada have significant portions of their populations that winter in South America (Godfrey 1986). The migrations of some species of shorebirds (e.g., Red Knot *Calidris canutus* and Hudsonian Godwit *Limosa haemastica*) are among the most spectacular animal movements known in the Western Hemisphere—from breeding grounds in the Canadian High Arctic to wintering grounds as far south as Tierra del Fuego at the southern tip of South America (Morrison 1984).

Until relatively recently, the details of these migrations have remained obscure, as has knowledge of the destinations of the birds while they are away from their breeding grounds; these so-called "wintering areas" are, of course, occupied during the summer in the southern hemisphere. The sheer remoteness of and difficulty of access to many of the key southern wintering areas made it impracticable for early investigators to obtain information that would allow an assessment to be made of the relative importance of various areas for different species (e.g., Cooke 1910; Wetmore 1926, 1927; Bent 1927, 1929), and it is only since the advent of aerial surveys that such investigations have been possible (Morrison and Myers 1987). Knowledge of the sites that are critically important to migratory species at different times of the year not only is of fundamental biological importance in understanding the life cycles of the species concerned, but also is essential for conservational planning, because the animals depend on such sites for their survival. Without a knowledge of all the key links in the chain of sites forming the migration system of the animals, conservation efforts will remain piecemeal. For highly migratory birds, such as shorebirds, it is essential that conservational planning be undertaken on an international scale, because intensive effort in one area may be of little use if populations and habitats are threatened in a remote but equally important area.

This volume presents results of the Canadian Wildlife Service South American Shorebird Atlas Project, a five-year program of aerial surveys undertaken to determine the major wintering areas used by Nearctic shorebirds on the coast of South America. This project was undertaken under the Canadian Wildlife Service Latin American Program, which was set up in 1980 to support projects of conservational interest dealing with groups of birds shared between Canada and Latin American countries. From 1982 to 1986, some 28 000 km of aerial surveys were carried out covering most of the coastline of South America, including almost all areas thought to contain significant shorebird habitat. The project involved extensive collaboration between the Canadian Wildlife Service team and cooperators from a wide variety of institutions in the host countries, including counterpart government agencies, universities, conservation organizations, industry, and the military. Our surveys were limited to the South American coastline during the wintering period for reasons of logistics. This is not meant to diminish the role of inland areas as wintering sites for some species or the importance of certain sections of coast as staging areas during migration. Both these topics urgently require study to complete the picture of Nearctic shorebird distribution in South America.

More than 2.9 million shorebirds were counted during the surveys, and this has enabled the principal wintering areas used by a number of species to be clearly identified. The results have also shown that many species concentrate to a remarkable degree on their wintering areas, with a relatively small number of sites supporting major portions of the censused population. These results, in conjunction with similar findings from surveys undertaken on migration areas in Canada and the United States (Morrison 1984; Morrison and Myers 1987), have been a key element leading to the recent international conservation initiative to set up the Western Hemisphere Shorebird Reserve System (Myers *et al.* 1987*a*, 1987*b*) to protect the key sites used by the birds throughout their ranges (Morrison 1983, 1984).

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Chapter 2

Methods

R.K. Ross and R.I.G. Morrison

2.1. Aerial survey procedures

Shorebird distribution was determined by aerial surveys of all parts of the coastline of South America thought to contain habitat suitable for shorebirds. Areas and years of coverage are shown in Fig. 2.1. Surveys were conducted using single- or twin-engined fixed-wing aircraft or helicopters (Table 2.1), flying at an altitude of 40–50 m above ground level and airspeed of 160–240 km·h^{-1}, depending on the density of birds being encountered and the characteristics of the aircraft. Helicopters or small, high-winged, single-engined aircraft (e.g., Cessna 180, 182, 206) were particularly suitable and were used wherever possible, as they provided the best visibility and maneuverability and slowest survey speeds. For particularly remote coastlines or extensive flights over tropical forest, twin-engined aircraft were considered necessary for reasons of safety.

Survey flight lines were chosen to cover as much of the available shorebird habitat as practicable. Flights were timed to coincide with high tide whenever possible, so that shorebirds would be encountered in roosting flocks along the water's edge. In such cases, or along coastlines with narrow tidal zones, the survey line ran approximately 50 m offshore, and the two principal observers (RIGM and RKR) counted from the same side of the aircraft. One observer sat in the copilot's seat, with the other observers in the rear of the aircraft. The two principal observers remained the same throughout all the flights to maximize consistency in shorebird counts between areas and years. Where numbers of birds were high and species varied, the two principal observers divided the species between them on the basis of size categories for counting. Where numbers and/or species diversity were low, replicate counts were made; counts were later compared, and the higher figure for species and/or size category was used for the analysis. Small differences in counts resulted from individual observers occasionally missing flocks because of involvement with navigation, habitat photography, or checking equipment. Where broad intertidal zones were encountered, flight lines were run approximately 100 m inshore of the water's edge, and the two principal observers counted from opposite sides of the aircraft, each recording all species of interest; counts were subsequently combined. Lagoons inland from the coast were also surveyed, with all likely habitats being examined from the aircraft. The third observer, the collaborating biologist from the host country, made various observations as appropriate: experienced personnel counted shorebirds or other species of interest, e.g., Neotropical species or other wildlife species, made habitat notes, and advised on areas of special interest; training in aerial survey techniques was provided as appropriate.

Tape cassette recorders were used to record all survey data, including observations of both birds and habitats. All shorebirds seen were noted; numbers were obtained by direct counting when small flocks were encountered, or by estimating the size of larger flocks. Shorebirds were identified to species wherever possible. In cases where specific identification was not practicable because large numbers of shorebirds occurred together in flocks of mixed species or birds were seen at a distance in poor light or during rough weather, shorebirds were assigned to one of three size categories—small, medium-sized, or large (see Table 2.2 for species included in each size category).

Small species were generally recorded by size category, since it was not practicable to distinguish the various smaller species of *Calidris* sandpipers from the air, with the exception of Sanderling *C. alba*, which could generally be identified from both appearance and habitat use. Despite these considerations, the bulk of small shorebirds recorded in a given geographical area were likely to be of one particular species: on the north coast of South America, for instance, most small sandpipers consisted of Semipalmated Sandpipers *C. pusilla*, whereas in southern Brazil and Argentina, White-rumped Sandpipers *C. fuscicollis* predominated. In some areas, small plovers of the genus *Charadrius* occurred in significant numbers. Medium-sized species could generally be identified, given good light and a slow survey speed, although Lesser Yellowlegs *Tringa flavipes* and Greater Yellowlegs *T. melanoleuca* were generally not separated. Large species were identifiable in almost all cases.

Ground-truthing operations to determine accuracy of counts were not undertaken, as it was considered both impracticable from a logistical point of view, given the often very remote coastlines and large distances involved, and doubtful whether appropriate correction factors could be developed that would be applicable to all of the extremely wide variety of conditions encountered during the surveys. Comparison of counts of the same flocks by the two principal observers indicated a high degree of consistency. Although the relationship between recorded numbers and absolute numbers occurring on the ground remains undetermined, it may be said that the numbers recorded will provide a minimum estimate of the numbers of birds present, and that the consistency of data collection by the same personnel in all years of the surveys will enable a valid comparison to be made of the relative numbers of

Figure 2.1
Areas and years of coverage of aerial surveys carried out under the Canadian Wildlife Service Shorebird Atlas Project, 1982–86

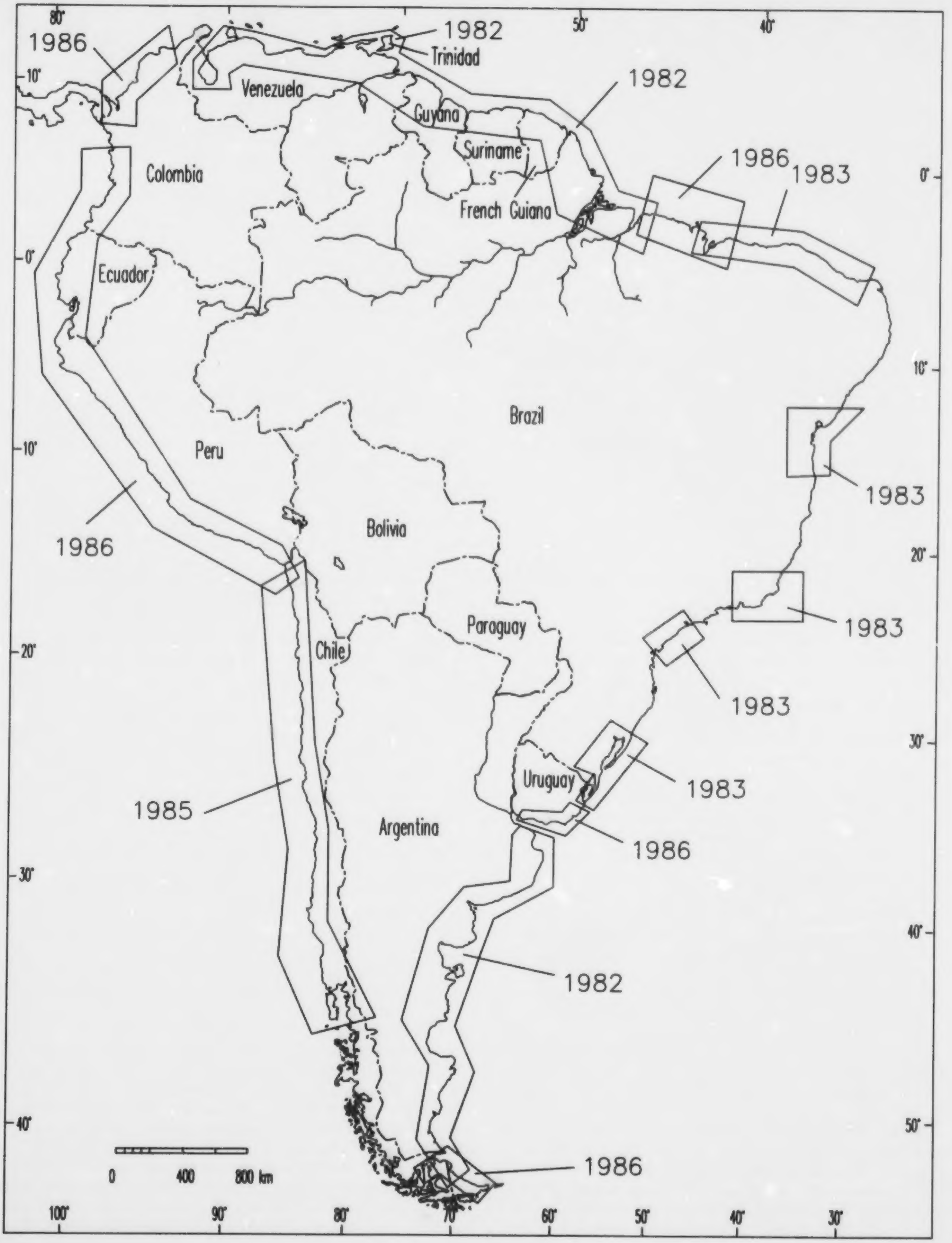
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Table 2.1
Schedule of coverage of eco-units and aircraft types used during aerial surveys of the coastline of South America, 1982-86

Eco-unit	Survey sectors (by country)	Survey date(s)	Aircraft type[a]
Venezuela - West Caribbean	1-45	11, 12 February 1982	Rockwell Aero-Commander (F)
Venezuela - Central Caribbean	46-57	12 February 1982	Rockwell Aero-Commander (F)
Venezuela - Orinoco	58-77	13 February 1982	Rockwell Aero-Commander (F)
Trinidad	1-27	17, 18 February 1982	Aérospatiale Gazelle (R)
Guyana	1-13	6 February 1982	Cessna 206 (F)
Suriname	1-14	3, 4 February 1982	Cessna 206 (F)
French Guiana	1-11	3 February 1982	Cessna 206 (F)
Brazil - North	1-12	28 January 1982	Britten-Norman Islander (F)
Brazil - Amazon	13-29	28 January 1982	Britten-Norman Islander (F)
Brazil - North-central	30-62	13-21 January 1986	MBB BO-105 (R)
Brazil - Northeast	63-73	13, 14 January 1983	Piper Seneca (F)
Brazil - East	74-80	17 January 1983	Cessna 206 (F)
Brazil - Rio	81-85	19 January 1983	Cessna 180 (F)
	86-89	7 January 1983	Britten-Norman Islander (F)
Brazil - Sao Paulo	90-96	26 January 1983	Cessna 180 (F)
Brazil - Rio Grande do Sul	97-120	23 January 1982	Cessna 210 (F)
Uruguay	1-20	24, 25 January 1986	Cessna 206 (F)
Argentina - Buenos Aires	1-22	13 January 1982	Rockwell Aero-Commander (F)
Argentina - Rio Colorado	23-33	13, 14 January 1982	Rockwell Aero-Commander (F)
Argentina - Peninsula Valdes	34-57	14 January 1982	Rockwell Aero-Commander (F)
Argentina - Golfo San Jorge	58-86	15 January 1982	Rockwell Aero-Commander (F)
Argentina - Rio Gallegos	87-115	15, 16 January 1982	Rockwell Aero-Commander (F)
Argentina - Tierra del Fuego	116-133	1 February 1985	Piper Cherokee (F)
Chile - Tierra del Fuego	1-20	29 January 1985	Beech Single Engine (F)
Chile - Chiloe	21-55	17, 18 January 1985	Cessna 182 (F)
Chile - Concepcion	56-78	19 January 1985	Cessna 182 (F)
Chile - Valparaiso	79-97	19, 20 January 1985	Cessna 182 (F)
Chile - La Serena	98-125	20, 21 January 1985	Cessna 182 (F)
Chile - Antofagasta	126-145	21, 22 January 1985	Cessna 182 (F)
Chile - Arica	146-165	22 January 1985	Cessna 182 (F)
Peru - Mollendo	1-23	4 February 1986	Cessna 182 (F)
Peru - Lima	24-46	4, 5 February 1986	Cessna 182 (F)
Peru - Chimbote	47-57	5 February 1986	Cessna 182 (F)
Peru - Chiclayo	58-85	5, 6 February 1986	Cessna 182 (F)
Ecuador	1-45	12, 13 February 1986	Cessna 206 (F)
Colombia - Pacific	1-24	20, 21 February 1986	Cessna 180 (F)
Colombia - Caribbean	25-53	21, 22 February 1986	Cessna 180 (F)

[a] R = rotary; F = fixed-wing.

birds occurring in different areas, one of the major objectives of the surveys.

In addition to recording shorebird numbers, descriptions were made and photographs taken of habitats at regular intervals throughout the survey flights. In 1985 and 1986, a video cassette recorder was used to obtain a continuous record of the coastline and habitats being covered. The video recorder was mounted by an inshore-facing window of the aircraft to provide coverage of the immediate habitat close to the aircraft. It was allowed to run continuously during the flight; oral notes of birds and habitats by the two principal observers were recorded on the audio tracks, providing a backup to the audio cassette recordings and allowing future referencing of shorebird sightings and habitat occurrence.

The shoreline was divided into survey sectors based on landmarks and differences in coastal morphology and habitat occurrence. During the flights, in addition to making shorebird and other bird counts, the forward observer navigated, took habitat photographs, and announced time checks to the other observers at sector boundaries and appropriate landmarks; an intercom with noise-limiting headphone sets facilitated communication within the aircraft and reduced fatigue. Times were recorded at regular, short intervals throughout the flights, enabling observations to be localized within each sector.

Surveys were carried out during January/February in each of the survey years (1982, 1983, 1985, 1986; see Table 2.1 and Fig. 2.1), when migratory movements are likely to be few. In the southern part of the continent, surveys were completed by the end of the first week in February, before northward migration had begun. Surveys were timed to occur at high tide wherever possible, although this was not always practicable with long stretches of coast to cover: surveys generally were conducted between 0800 and 1600 hours to avoid glare caused by low sun angles. Weather was rarely a problem during the surveys, with clear skies occurring around much of the continent during the survey periods; fog or heavy rain caused delays on only two occasions, although weather conditions were variable in the southern parts of the continent and during the rainy season on the north coast.

Table 2.2
Size categories of principal species of Nearctic shorebirds observed during aerial surveys of the coast of South America, 1982–86

Size category	Species
Small	Semipalmated Plover *Charadrius semipalmatus*
	Solitary Sandpiper *Tringa solitaria*
	Spotted Sandpiper *Actitis macularia*
	Sanderling *Calidris alba*
	Semipalmated Sandpiper *C. pusilla*
	Western Sandpiper *C. mauri*
	Least Sandpiper *C. minutilla*
	White-rumped Sandpiper *C. fuscicollis*
	Baird's Sandpiper *C. bairdii*
	Pectoral Sandpiper *C. melanotos*
	Buff-breasted Sandpiper *Tryngites subruficollis*
Medium-sized	Black-bellied Plover *Pluvialis squatarola*
	Lesser Golden-Plover *P. dominica*
	Greater Yellowlegs *Tringa melanoleuca*
	Lesser Yellowlegs *T. flavipes*
	Upland Sandpiper *Bartramia longicauda*
	Ruddy Turnstone *Arenaria interpres*
	Surfbird *Aphriza virgata*
	Red Knot *Calidris canutus*
	Stilt Sandpiper *C. himantopus*
	Short-billed Dowitcher *Limnodromus griseus*
	Wilson's Phalarope *Phalaropus tricolor*
Large	Willet *Catoptrophorus semipalmatus*
	Whimbrel *Numenius phaeopus*
	Hudsonian Godwit *Limosa haemastica*

2.2. Data analysis

After transcription, survey data were summarized by sector within each country. Survey sectors were numbered consecutively in a clockwise fashion by country around the continent, and their lengths calculated from aeronautical charts (scale 1:1 000 000) or other maps based on the flight lines followed. Sector lengths averaged 38.4 km. A computerized database was created, using dBase III Plus (Ashton-Tate), from which subsequent analyses were performed.

Results are generally presented on the basis of survey sectors. For consideration of the broader aspects of shorebird distribution, survey sectors were combined to form a series of "eco-units," each of which formed a geographical entity of broadly similar habitat, e.g., the Orinoco delta, the Amazon River mouth, and the Atlantic coast of Tierra del Fuego. Eco-unit names and locations are given in Table 2.1 and Fig. 2.2. For regional analysis, eco-units were grouped into three main regions comprising the "North Coast," "Atlantic Coast," and "Pacific Coast," as shown in Fig. 2.2. Where reference has been made to regional totals in discussing results in the text, the name of the region has been capitalized.

Numbers in the tables are unaltered survey data. In the text, numbers have generally been rounded as follows: 0–50, unchanged; 50–1000, to nearest 10; 1000–100 000, to nearest 100; 100 000–1 000 000, to nearest 1000. Percentages have been calculated using unrounded numbers.

Simple qualitative habitat descriptions of each sector are presented in tables that accompany each base map. These descriptions are divided by diagonal strokes into two or three segments representing different zones on the shore. The first segment describes the major littoral habitats on which the shorebirds were found. The second outlines the shorebird habitat above the water line. Where necessary, a third segment lists habitats occurring farther inland, where they differ from those on the shoreline. Within each survey sector, a variety of habitats usually occurred, and these are listed for each zone in decreasing order of dominance.

2.3. Map production

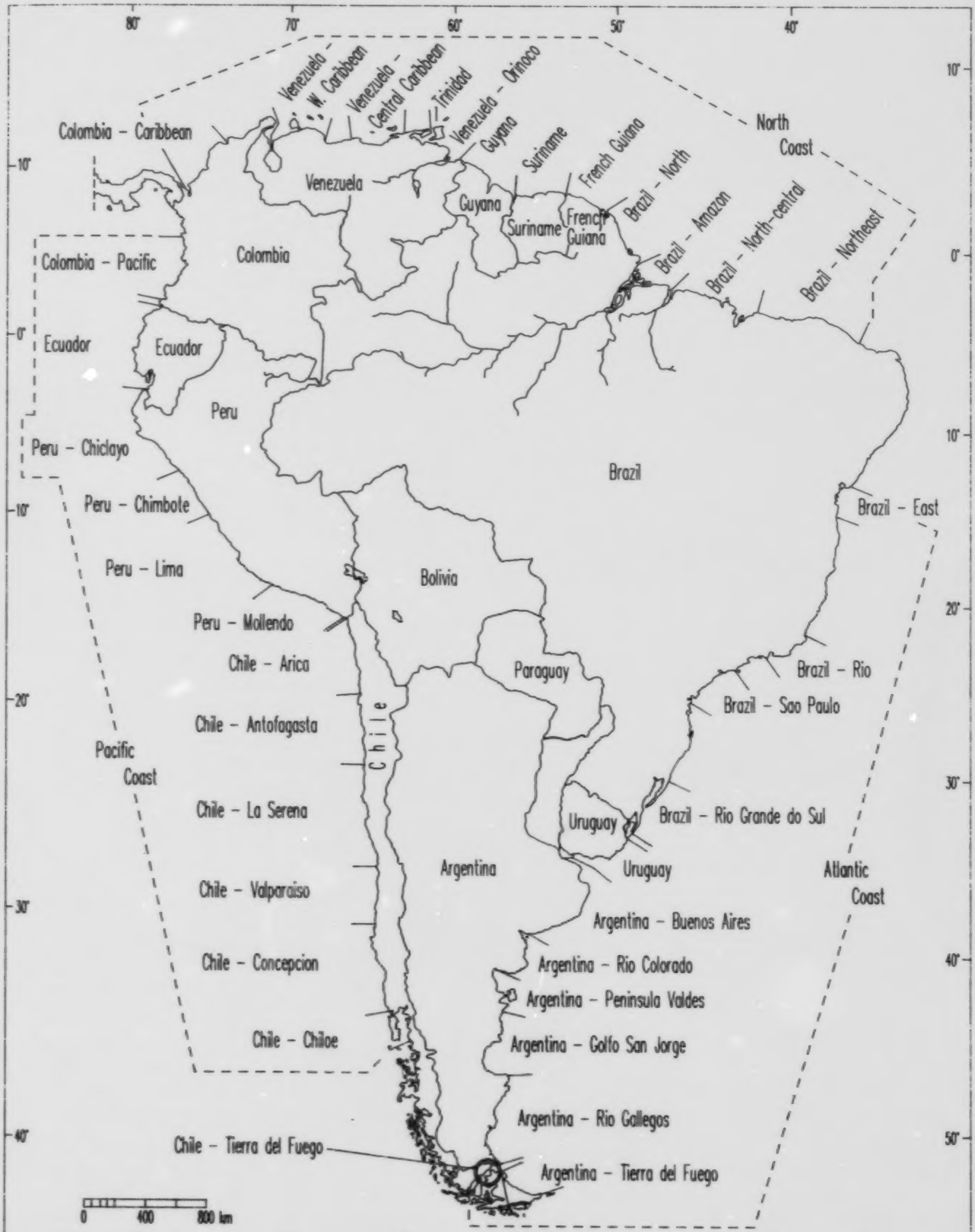
A series of base maps was created from 1:1 000 000 aeronautical charts using the Autocad computer program (Autodesk Inc.) with an IBM-PC-AT computer, covering the coastline of the South American continent. To these maps were added geographical information, survey sector data, and shorebird totals summarized by size category (symbols labelled S, M, and L indicate small, medium-sized, and large shorebirds, respectively). The computerized mapping system allowed considerable flexibility in editing and production of maps.

Names of large geographical features generally appear in the English form (e.g., Amazon River, Lake Maracaibo), whereas names of lesser-known or smaller features are given in the appropriate language (e.g., Rio Capim, Lagoa do Peixe, Bahia Blanca). Accents have generally been omitted from place names, both on the maps (their inclusion was not possible with the mapping program) and in the text.

2.4. Limitations of the data

The survey results, particularly at the site level, are subject to some variability, for several reasons. First, there may be substantial annual shifts in population levels of some species, particularly those from the high Arctic, where breeding conditions are extremely variable. As well, there is the possibility of short-term redistribution of shorebirds along the coastal wintering area in response to environmental conditions, such as El Nino. Shorebirds may also travel some distance in their daily search for food, so the size of the area they use may not be evident from a single survey. Finally, in a venture of this magnitude, it was occasionally necessary to cover areas under less-than-ideal conditions, such as at low tide, that increased the possibility of missing birds. Flight restrictions, usually around militarily sensitive areas, prevented us from surveying a few potentially interesting sites; these sites are noted in the text. Because of this variability, care must be taken in using the site-specific data, particularly when making conservation decisions: high bird counts at a certain location usually reflect not only the conditions at that site, but also the advantageous combination of habitats provided by the general area.

Figure 2.2
Locations of eco-units and regions on the coast of South America


80°
70°
60°
50°
40°
10°
Venezuela - W. Caribbean
Venezuela - Central Caribbean
Trinidad
Venezuela - Orinoco
Guyana
Suriname
French Guiana
Brazil - North
Brazil - Amazon
Brazil - North-central
Brazil - Northeast
North Coast
Colombia - Caribbean
Venezuela
Guyana
Suriname
French Guiana
Colombia
Colombia - Pacific
0°
Ecuador
Ecuador
Peru
Peru - Chiclayo
Brazil
Peru - Chimbote
Brazil - East
Peru - Lima
Bolivia
Peru - Mollendo
Chile - Arica
Paraguay
Brazil - Rio
Brazil - Sao Paulo
Chile - Antofagasta
Chile
Pacific Coast
Chile - La Serena
Uruguay
Brazil - Rio Grande do Sul
Uruguay
Argentina
Atlantic Coast
Chile - Valparaiso
Argentina - Buenos Aires
Chile - Concepcion
Argentina - Rio Colorado
Argentina - Peninsula Valdes
Argentina - Golfo San Jorge
Chile - Chiloe
Argentina - Rio Gallegos
Chile - Tierra del Fuego
Argentina - Tierra del Fuego
0
400
800 km
100°
90°
80°
70°
60°
50°
40°
30°
-10°
-20°
-30°
-40°
20°
30°
40°
50°

Chapter 3

Overview

R.I.G. Morrison and R.K. Ross

3.1. General patterns of shorebird distribution in South America

The surveys covered some 28 000 km of the coastline of South America and included all stretches of coast thought to contain any significant shorebird habitat (see Chapter 2). More than 2.9 million Nearctic shorebirds were counted during the surveys: totals are summarized for the three major size categories by countries in Table 3.1. Small species were numerically predominant (for species compositions of each size category, see Chapter 2), comprising 79.7% of the total, with medium-sized and large species making up a further 15.7 and 4.2%, respectively. Uncategorized birds made up 0.4% of the total.

On the basis of numbers alone, the north coast of South America was clearly the most important wintering area for Nearctic shorebirds, holding nearly 2.5 million, or 85.6%, of the total for South America, with the Pacific coast holding some 218 000 (7.5%) and the Atlantic coast some 203 000 (7.0%) (Table 3.2). This result reflects the abundance of small shorebirds on the north coast; other areas were of great significance for other groups of species or individual species. On the north coast, distribution of small species was centred on the Guianas, with Suriname (57.9%) and French Guiana (16.9%) together holding some 75% of the South American total; other important areas included Brazil (10.9%) and parts of Peru (3.9%), Chile (2.2%), and Argentina (1.8%). For medium-sized shorebirds, the north coast was also important: 42.2% of the South American total occurred in the Guianas (Suriname 32.4%, French Guiana 7.2%, Guyana 2.5%), with substantial numbers wintering in Brazil (24.1%), Chile (9.7%), Venezuela (7.1%), Argentina (6.6%), and Peru (5.1%). Brazil held the largest percentage of the total of large species (29.0%), with other important wintering areas for species in this group including Chile (26.4%), Suriname (17.8%), and Argentina (17.2%).

3.2. Distribution of the major groups and species of Nearctic shorebirds in South America

To describe the distribution patterns of shorebirds in South America, the coastline was broken down into 36 eco-units, each of which represented a natural geographical, ecological, and/or political unit, with a distinctive ecological character (see Fig. 2.2, Chapter 2). Totals of shorebirds occurring in each eco-unit are summarized by size category in Table 3.2 and by species in Table 3.3*a*–*c*. Distribution patterns for the various size categories and species are illustrated in Maps 3.1–3.12. Locations of major wintering areas are shown on the inside front cover.

3.2.1. Small shorebirds

The distribution of small shorebirds in South America is shown in Map 3.1. This group consisted principally of small sandpipers in the genus *Calidris*, as well as the smaller plovers in the genus *Charadrius*. It was generally impracticable to identify the closely similar species in this group consistently from the air, with the exception of Sanderling *Calidris alba*, which could be counted separately owing to its distinctive appearance and characteristic occurrence on ocean beach habitats (see Section 3.2.2.). Spotted Sandpipers *Actitis macularia* could often be identified on mangrove coastlines in areas of low bird densities, although separation became impracticable as larger flocks of mixed species occurred.

Despite these factors affecting identification, both aerial and ground observations indicated that the largest flocks of peeps (small sandpipers) occurring in different regions of the continent usually consisted predominantly of a single species. On the north coast, this was the Semipalmated Sandpiper *Calidris pusilla*, whereas on the southern half of the Atlantic coast from southern Brazil to Tierra del Fuego, the majority of peeps were White-rumped Sandpipers *C. fuscicollis*. The patterns shown in Map 3.1 in these two regions may thus be taken as representative of the coastal distributions of the two species concerned in South America.

A number of general features are apparent from Map 3.1. By far the largest numbers of small sandpipers, mostly Semipalmated Sandpipers, occur on the north coast of the continent, centred on Suriname and the Guianas. Of the total of over 2 083 000 peeps on the north coast of South America, 64.6% were found in Suriname, with a further 18.9% in French Guiana and 0.5% in Guyana, so that the Guianas held some 84% of the total. Other important areas on the north coast included the north-central coast of Brazil, which held 9.2% of the total, and the Orinoco delta in Venezuela, which held an additional 3.3%.

Relatively few small shorebirds were found in tropical habitats on the northern half of the Atlantic (eastern) coast, despite the occurrence of estuaries or bays with mudflats and mangrove formations in the area of Salvador. A similar phenomenon was noted on the northern half of the Pacific coast: many areas with what appeared to be suitable estuarine habitats, such as the Gulf of Guayaquil and Buenaventura Bay, contained relatively few small shorebirds.

Table 3.1
Totals by country of Nearctic shorebirds counted during aerial surveys of the coastline of South America, 1982–86

Country/Parameter	Survey length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Unclassified shorebirds	Total shorebirds
Venezuela	1 938.0					
No. of birds		94 476	32 473	1 405	1 411	129 765
% of size-class total (South America)		4.06	7.10	1.16	10.77	4.45
% of grand total (South America)		3.24	1.11	0.05	0.05	4.45
Trinidad	483.8					
No. of birds		12 393	986	259	0	13 638
% of size-class total (South America)		0.53	0.22	0.21	0.00	0.47
% of grand total (South America)		0.42	0.03	0.01	0.00	0.47
Guyana	478.5					
No. of birds		9 808	11 618	340	0	21 766
% of size-class total (South America)		0.42	2.54	0.28	0.00	0.75
% of grand total (South America)		0.34	0.40	0.01	0.00	0.75
Suriname	369.8					
No. of birds		1 346 625	148 168	21 536	10 000	1 526 329
% of size-class total (South America)		57.85	32.42	17.75	76.31	52.28
% of grand total (South America)		46.13	5.08	0.74	0.34	52.28
French Guiana	388.2					
No. of birds		394 334	32 906	2 094	1 500	430 834
% of size-class total (South America)		16.94	7.20	1.73	11.45	14.76
% of grand total (South America)		13.51	1.13	0.07	0.05	14.76
Brazil	7 852.5					
No. of birds		252 812	110 258	35 147	0	398 217
% of size-class total (South America)		10.86	24.12	28.97	0.00	13.64
% of grand total (South America)		8.66	3.78	1.20	0.00	13.64
Uruguay	621.9					
No. of birds		3 137	6 960	422	0	10 519
% of size-class total (South America)		0.13	1.52	0.35	0.00	0.36
% of grand total (South America)		0.11	0.24	1.01	0.00	0.36
Argentina	4 549.0					
No. of birds		41 429	30 195	20 806	194	92 624
% of size-class total (South America)		1.78	6.61	17.55	1.48	3.17
% of grand total (South America)		1.42	1.03	0.71	0.01	3.17
Chile	5 487.5					
No. of birds		51 186	44 432	32 019	0	127 637
% of size-class total (South America)		2.20	9.72	26.39	0.00	4.37
% of grand total (South America)		1.75	1.52	1.10	0.00	4.37
Peru	2 774.3					
No. of birds		89 675	23 367	2 234	0	115 276
% of size-class total (South America)		3.85	5.11	1.84	0.00	3.95
% of grand total (South America)		3.07	0.80	0.08	0.00	3.95
Ecuador	1 385.5					
No. of birds		2 274	3 485	4 006	0	9 765
% of size-class total (South America)		0.10	0.76	3.30	0.00	0.33
% of grand total (South America)		0.08	0.12	0.14	0.00	0.33
Colombia	1 600.6					
No. of birds		29 673	12 238	1 049	0	42 960
% of size-class total (South America)		1.27	2.68	0.86	0.00	1.47
% of grand total (South America)		1.02	0.42	0.04	0.00	1.47
Total	27 929.6	2 327 822	457 086	121 317	13 105	2 919 330
% of grand total (South America)		79.74	15.66	4.16	0.45	100.00

Banding studies (Morrison and Spaans 1979; Spaans 1984), museum collections (unpubl. results), and field observations (Spaans 1978, 1979) have shown that the majority of small shorebirds classified as peeps on the north coast are Semipalmated Sandpipers, although the closely related Western Sandpiper *Calidris mauri* also occurs. Large numbers of Western Sandpipers occur on migration on the west coast of North America (e.g., Copper River delta and the Fraser River delta; Senner *et al.* 1981). Yet the proportion of Western Sandpipers in wintering populations on the north coast is low, and relatively small numbers of peeps have been found wintering on the northwest Pacific coast of South America. This suggests that the main wintering areas of the Western Sandpiper may be north of the South American continent. Large numbers have been found recently, for instance, in Panama (RIGM, RKR, and F. Delgado, unpubl. results; B.A. Harrington and J.P. Myers, pers. commun.).

Semipalmated Sandpipers show a cline in size across their breeding grounds, with the largest birds in the eastern Arctic and the smallest birds in Alaska (Harrington and Morrison 1979). This cline is reflected to some extent in the measurements of birds across the north coast of South America; the larger birds wintering on the north coast of Brazil probably derive from breeding grounds in the eastern Arctic, with smaller birds on the western parts

Table 3.2
Summary by size category of Nearctic shorebirds in regions and in eco-units on the coast of South America

Region/Eco-unit	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Unclassified shorebirds	Total shorebirds
North Coast						
Colombia - Caribbean	853.7	4 955	6 014	50	0	11 019
Venezuela - West Caribbean	1 113.2	9 640	10 205	406	1 411	21 662
Venezuela - Central Caribbean	275.6	15 203	8 240	519	0	23 962
Venezuela - Orinoco	549.2	69 633	14 028	480	0	84 141
Trinidad	483.8	12 393	986	259	0	13 638
Guyana	478.5	9 808	11 618	340	0	21 766
Suriname	369.8	1 346 625	148 168	21 536	10 000	1 526 329
French Guiana	388.2	394 334	32 906	2 094	1 500	430 834
Brazil - North	464.3	25 598	2 323	674	0	28 595
Brazil - Amazon	633.8	2 080	621	7	0	2 708
Brazil - North-central	2 504.7	195 531	97 227	34 133	0	326 891
Brazil - Northeast	1 248.4	3 009	2 760	183	0	5 952
Regional total (North Coast)	9 363.2	2 088 809	335 096	60 681	12 911	2 497 497
Atlantic Coast						
Brazil - East	939.0	1 817	679	143	0	2 639
Brazil - Rio	394.9	688	4 885	0	0	5 573
Brazil - Sao Paulo	784.5	11	1	0	0	12
Brazil - Rio Grande do Sul	882.9	24 078	1 762	7	0	25 847
Uruguay	621.9	3 137	6 960	422	0	10 519
Argentina - Buenos Aires	921.8	1 625	1 994	482	103	4 204
Argentina - Rio Colorado	910.5	4 967	1 846	318	0	7 131
Argentina - Peninsula Valdes	784.9	1 815	5 086	0	1	6 902
Argentina - Golfo San Jorge	730.9	7 559	9 128	357	90	17 134
Argentina - Rio Gallegos	770.9	1 700	550	163	0	2 413
Argentina - Tierra del Fuego	430.0	23 763	11 591	19 486	0	54 840
Chile - Tierra del Fuego	619.2	11 210	43 206	11 779	0	66 195
Regional total (Atlantic Coast)	8 791.4	82 370	87 688	33 157	194	203 409
Pacific Coast						
Chile - Chiloe	1 432.0	19 164	789	18 856	0	38 809
Chile - Concepcion	880.7	4 563	51	617	0	5 231
Chile - Valparaiso	543.0	9 166	87	384	0	9 637
Chile - La Serena	846.2	4 395	108	291	0	4 794
Chile - Antofagasta	582.8	1 327	128	33	0	1 488
Chile - Arica	583.6	1 361	63	59	0	1 483
Peru - Mollendo	683.9	14 854	6 393	81	0	21 328
Peru - Lima	792.7	19 995	2 335	988	0	23 318
Peru - Chimbote	426.1	2 171	435	65	0	2 671
Peru - Chiclayo	871.6	52 655	14 204	1 100	0	67 959
Ecuador	1 385.5	2 274	3 485	4 006	0	9 765
Colombia - Pacific	746.9	24 718	6 224	999	0	31 941
Regional total (Pacific Coast)	9 775.0	156 643	34 302	27 479	0	218 424
Total	27 929.6	2 327 822	457 086	121 317	13 105	2 919 330

of the north coast and on the northern part of the Pacific coast likely coming from the western sectors of the breeding grounds (Morrison 1983, 1984).

Moderate concentrations of small shorebirds were found on the southern half of the Atlantic coast, particularly in Rio Grande do Sul in southern Brazil and in Tierra del Fuego (Argentina and Chile). Observations and banding studies have shown that few Semipalmated Sandpipers occur this far south and that the majority of the birds are White-rumped Sandpipers. The most important wintering areas discovered were along the Atlantic coast of Tierra del Fuego in Argentina, which held 31.9% of the regional total of some 73 000 peeps; Chilean sectors of Tierra del Fuego, involving mostly the areas bordering the Strait of Magellan, were also important, with a further 15.3% of the regional total. Another particularly important area comprised the lagoons in Rio Grande do Sul state in southern Brazil, especially the Lagoa do Peixe; these were the most important areas outside Tierra del Fuego, holding 20.7% of the regional total, with coastal lagoons in Uruguay holding a further 4.3%. Smaller numbers were encountered along the Atlantic coast of Argentina, the most important stretches of coast occurring around the Golfo San Jorge.

Most of the birds thus occurred on rocky *restingas* along the Argentinian coast, on intertidal rocky areas or mudflats, or in lagoons. Few inland habitats were covered in coastal areas of Buenos Aires province, although these are known to hold substantial numbers of wintering White-rumped Sandpipers and Baird's Sandpipers *Calidris bairdii* (Myers and Myers 1979).

3.2.2. Sanderling *Calidris alba*

Nearly 112 000 Sanderlings were observed on the surveys. The most important wintering areas were clearly on the long ocean beaches of the Pacific coast (Map 3.2), which held 87.8% of the total, with the Atlantic and north coasts holding only 8.3 and 3.9% of the total, respectively. Sanderlings were the most numerous small shorebird along the beaches of the Pacific coast, comprising 94–100% of birds in this category in the eco-units between Chiloe in southern Chile and the northern coast of Peru.

Peru (68.1%) and Chile (30.8%) between them held 98.9% of the Sanderlings wintering on the Pacific

Table 3.3a
Species totals of Nearctic shorebirds in regions and in eco-units on the coast of South America—small shorebirds

Region/Eco-unit	Eco-unit length (km)	Semi-palmated Plover	Spotted Sandpiper	Solitary Sandpiper	Pectoral Sandpiper	White-rumped Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
North Coast									
Colombia - Caribbean	853.7	0	28	0	0	0	56	4 871	4 955
Venezuela - West Caribbean	1 113.2	0	10	0	0	0	194	9 436	9 640
Venezuela - Central Caribbean	275.6	0	1	0	0	0	0	15 202	15 203
Venezuela - Orinoco	549.2	0	7	0	0	0	460	69 166	69 633
Trinidad	483.8	0	21	0	0	0	5	12 367	12 393
Guyana	478.5	0	23	0	0	0	30	9 755	9 808
Suriname	369.8	0	10	0	0	0	42	1 346 573	1 346 625
French Guiana	388.2	0	5	0	0	0	2	394 327	394 334
Brazil - North	464.3	0	2	0	0	0	2	25 594	25 598
Brazil - Amazon	633.8	470	4	0	0	0	117	1 489	2 080
Brazil - North-central	2 504.7	0	246	1	0	0	3 080	192 204	195 531
Brazil - Northeast	1 248.4	0	3	0	0	0	380	2 626	3 009
Regional total (North Coast)	9 363.2	470	360	1	0	0	4 368	2 083 610	2 088 809
Atlantic Coast									
Brazil - East	939.0	0	20	1	65	0	261	1 470	1 817
Brazil - Rio	394.9	0	2	0	0	0	524	162	688
Brazil - Sao Paulo	784.5	0	0	0	0	0	0	11	11
Brazil - Rio Grande do Sul	882.9	0	0	0	1	2 340	6 618	15 119	24 078
Uruguay	621.9	0	3	0	0	1	5	3 128	3 137
Argentina - Buenos Aires	921.8	0	0	0	0	0	253	1 372	1 625
Argentina - Rio Colorado	910.5	0	0	0	0	0	240	4 727	4 967
Argentina - Peninsula Valdes	784.9	0	0	0	0	0	777	1038	1 815
Argentina - Golfo San Jorge	730.9	0	0	0	0	0	75	7 484	7 559
Argentina - Rio Gallegos	770.9	0	0	0	0	0	0	1 700	1 700
Argentina - Tierra del Fuego	430.0	0	0	0	0	0	504	23 259	23 763
Chile - Tierra del Fuego	619.2	0	0	0	0	0	25	11 185	11 210
Regional total (Atlantic Coast)	8 791.4	0	25	1	66	2 341	9 282	70 655	82 370
Pacific Coast									
Chile - Chiloe	1 432.0	0	0	0	0	0	10 194	8 970	19 164
Chile - Concepcion	880.7	0	0	0	0	0	4 543	20	4 563
Chile - Valparaiso	543.0	0	0	0	0	0	8 442	724	9 166
Chile - La Serena	846.2	0	0	0	0	0	4 395	0	4 395
Chile - Antofagasta	582.8	0	0	0	0	0	1 327	0	1 327
Chile - Arica	583.6	0	0	0	0	0	1 361	0	1 361
Peru - Mollendo	683.9	0	1	0	0	0	14 242	611	14 854
Peru - Lima	792.7	0	1	0	0	0	18 831	1 163	19 995
Peru - Chimbote	426.1	0	8	0	0	0	2 163	0	2 171
Peru - Chiclayo	871.6	0	23	0	0	0	31 610	21 022	52 655
Ecuador	1 385.5	0	5	0	0	0	230	2 039	2 274
Colombia - Pacific	746.9	0	8	0	0	0	827	23 883	24 718
Regional total (Pacific Coast)	9 775.0	0	46	0	0	0	98 165	58 432	156 643
Total	27 929.6	470	431	2	66	2 341	111 815	2 212 697	2 327 822

coast. The most important areas occurred in northern Peru, particularly in the Chiclayo region, where nearly 32 000 (32.2% of the Pacific Coast total) birds were counted. Especially important areas included the coastline near Pacasmayo, where over 11 000 were found, and the huge ocean beach fronting the Sechura Desert. Beaches in central and southern Peru also held large numbers, with 19.1 and 14.5% of the Pacific Coast total, respectively. Moderate to large concentrations occurred along the beaches of central and southern Chile, and the Chiloe area held 10.4% of the Pacific Coast total, over 2500 birds being found near Coulin on the north coast of Chiloe Island.

Moderate to small numbers of Sanderlings occurred on the southern half of the Atlantic coast of South America. The ocean beaches of Rio Grande do Sul, Brazil, held 70.5% of the regional total of 9300; beaches adjacent to the coastal lagoons, especially the Lagoa do Peixe, were most heavily used.

Even fewer Sanderlings were identified on the north coast of South America, the regional total of 4400 representing only 3.9% of the South American total. The majority (71.3%) of these birds were found on the sandy outer headlands of the highly indented north-central coast of Brazil, especially near Sao Luis.

Densities as well as numbers were higher on the Pacific coast than on the Atlantic coast (see also Morrison 1984; Myers *et al.* 1985). The highest recorded density was 1095 birds per kilometre, involving large roosting flocks (7700 birds) in a short survey sector (7.03 km) covering the mouth of the Rio Pisco in Peru. Highest densities elsewhere occurred in northern Peru along the coastlines of and adjacent to the Sechura Desert. Densities reached 278 birds per kilometre around Pacasmayo and 186 birds per kilometre near the northwestern end of the Sechura Desert beach: the mean density in this general area was 117 birds per kilometre. Densities were also high in southern Peru near the border with Chile, reaching 242 birds per kilometre near Tacna. Elsewhere in Peru and Chile, high densities were generally in the range 25 to 60 birds per kilometre. On the Atlantic coast, the highest density recorded was in Rio Grande do Sul in southern Brazil on

Table 3.3*b*
Species totals of Nearctic shorebirds in regions and in eco-units on the coast of South America—medium-sized shorebirds

Region/Eco-unit	Eco-unit length (km)	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Surfbird	Yellowlegs species	Red Knot	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
North Coast										
Colombia - Caribbean	853.7	0	1 241	175	0	19	0	1 558	3 020	6 014
Venezuela - West Caribbean	1 113.2	0	212	219	0	1 290	520	0	7 964	10 205
Venezuela - Central Caribbean	275.6	0	48	0	0	779	0	7 113	300	8 240
Venezuela - Orinoco	549.2	0	143	42	0	308	0	3 100	10 435	14 028
Trinidad	483.8	0	173	6	0	518	0	209	80	986
Guyana	478.5	0	598	48	0	6 824	0	2 900	1 248	11 618
Suriname	369.8	0	3 940	619	0	66 377	0	21 840	55 392	148 168
French Guiana	388.2	0	640	601	0	5 117	0	2 400	24 148	32 906
Brazil - North	464.3	47	676	191	0	205	120	20	1 064	2 323
Brazil - Amazon	633.8	0	101	4	0	227	0	150	139	621
Brazil - North-central	2 504.7	0	14 711	17 909	0	798	8 191	8 105	47 508	97 227
Brazil - Northeast	1 248.4	82	1 289	433	0	218	15	35	688	2 760
Regional total (North Coast)	9 363.2	129	23 772	20 247	0	82 686	8 846	47 430	151 986	335 096
Atlantic Coast										
Brazil - East	939.0	0	168	321	0	59	0	0	131	679
Brazil - Rio	394.9	0	76	1	0	4 808	0	0	0	4 885
Brazil - Sao Paulo	784.5	0	0	0	0	0	0	0	1	1
Brazil - Rio Grande do Sul	882.9	629	3	0	0	419	0	0	711	1 762
Uruguay	621.9	3 167	365	253	0	88	0	0	3 087	6 960
Argentina - Buenos Aires	921.8	85	0	0	0	642	0	0	1 267	1 994
Argentina - Rio Colorado	910.5	30	5	0	0	1	50	0	1 760	1 846
Argentina - Peninsula Valdes	784.9	0	5	0	0	55	5 023	0	3	5 086
Argentina - Golfo San Jorge	730.9	0	0	320	0	17	8 691	0	100	9 128
Argentina - Rio Gallegos	770.9	0	0	0	0	0	550	0	0	550
Argentina - Tierra del Fuego	430.0	0	0	1	0	0	10 470	0	1 120	11 591
Chile - Tierra del Fuego	619.2	0	0	2	0	14	42 762	0	428	43 206
Regional total (Atlantic Coast)	8 791.4	3 911	622	898	0	6 103	67 546	0	8 608	87 688
Pacific Coast										
Chile - Chiloe	1 432.0	0	0	0	20	164	0	0	605	789
Chile - Concepcion	880.7	0	0	0	0	36	0	0	15	51
Chile - Valparaiso	543.0	0	2	0	20	10	0	0	55	87
Chile - La Serena	846.2	14	4	29	61	0	0	0	0	108
Chile - Antofagasta	582.8	0	0	113	15	0	0	0	0	128
Chile - Arica	583.6	1	22	6	4	0	0	0	30	63
Peru - Mollendo	683.9	0	587	156	45	918	0	0	4 644	6 393
Peru - Lima	792.7	0	440	582	0	497	0	0	756	2 335
Peru - Chimbote	426.1	0	114	259	30	30	0	0	2	435
Peru - Chiclayo	871.6	0	203	911	2	454	0	0	12 633	14 204
Ecuador	1 385.5	0	1 082	109	0	135	0	825	1 334	3 485
Colombia - Pacific	746.9	0	419	189	0	20	0	604	4 992	6 224
Regional total (Pacific Coast)	9 775.0	15	2 873	2 354	197	2 368	0	1 429	25 066	34 302
Total	27 929.6	4 055	27 267	23 499	197	91 047	76 392	48 859	185 660	457 086

the coast near the Lagoa do Peixe (69 birds per kilometre); on the northern coast it was 25 birds per kilometre near Sao Luis.

Colour-marking studies (Myers *et al.* 1984) have shown that many of the Sanderlings wintering on the Pacific coast migrate northwards to the breeding grounds either via the west coast of North America or centrally up the Texas coast of the Gulf of Mexico and across the Prairies, with the migration southwards via the east coast of North America or the interior. Many birds thus carry out an elliptical, clockwise migration. The majority of birds migrating northwards along the Atlantic coast of the United States in spring through major staging areas such as Delaware Bay are not thought to come from Pacific coast wintering grounds in South America, but most likely consist of the population wintering on the Atlantic side of South America.

3.2.3. Medium-sized shorebirds

Some 457 000 medium-sized shorebirds were counted on the surveys (Table 3.2). Several centres of distribution occurred, with different species predominating in different regions (Map 3.3, Table 3.3*b*). The north coast of the continent was particularly important, especially for Black-bellied Plovers *Pluvialis squatarola*, Ruddy Turnstones *Arenaria interpres*, yellowlegs *Tringa* spp., and dowitchers *Limnodromus* spp. The Guianas alone held 42.1% of the medium-sized shorebird total for South America (Suriname 32.4%, French Guiana 7.2%, Guyana 2.5%), with north-central Brazil also holding very significant numbers (21.3%). The large numbers of medium-sized shorebirds wintering in Argentina and Chile (6.6 and 9.7%, respectively) consisted mainly of Red Knots *Calidris canutus* along the coastlines of Tierra del Fuego and Patagonia. Relatively few medium-sized shorebirds were found along the Pacific coasts of Chile or Peru: turnstones and Black-bellied Plovers were among the most common species in this size category on beaches, with yellowlegs, Black-bellied Plovers, and a variety of other species occurring in coastal marshes. Moderate numbers of medium-sized shorebirds occurred on the mudflats along the Pacific coastlines of Ecuador and Colombia.

Table 3.3c
Species totals of Nearctic shorebirds in regions and in eco-units on the coast of South America—large shorebirds

Region/Eco-unit	Eco-unit length (km)	Whimbrel	Willet	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds
North Coast						
Colombia - Caribbean	853.7	29	21	0	0	50
Venezuela - West Caribbean	1 113.2	114	121	0	171	406
Venezuela - Central Caribbean	275.6	5	464	0	50	519
Venezuela - Orinoco	549.2	207	273	0	0	480
Trinidad	483.8	75	184	0	0	259
Guyana	478.5	57	283	0	0	340
Suriname	369.8	3 310	15 646	0	2 580	21 536
French Guiana	388.2	326	729	0	1 039	2 094
Brazil - North	464.3	138	25	0	511	674
Brazil - Amazon	633.8	0	0	0	2	7
Brazil - North-central	2 504.7	10 879	21 868	4	1 382	34 133
Brazil - Northeast	1 248.3	117	26	0	40	183
Regional total (North Coast)	9 363.2	15 257	39 640	4	5 775	60 681
Atlantic Coast						
Brazil - East	939.0	66	77	0	0	143
Brazil - Rio	394.9	0	0	0	0	0
Brazil - Sao Paulo	784.5	0	0	0	0	0
Brazil - Rio Grande do Sul	882.9	3	0	0	4	7
Uruguay	621.9	2	0	326	94	422
Argentina - Buenos Aires	921.8	6	0	429	47	482
Argentina - Rio Colorado	910.5	0	0	313	5	318
Argentina - Peninsula Valdes	784.9	0	0	0	0	0
Argentina - Golfo San Jorge	730.9	0	0	352	5	357
Argentina - Rio Gallegos	770.9	0	0	160	3	163
Argentina - Tierra del Fuego	430.0	14	0	19 472	0	19 486
Chile - Tierra del Fuego	619.2	119	0	11 660	0	11 779
Regional total (Atlantic Coast)	8 791.4	210	77	32 712	158	33 157
Pacific Coast						
Chile - Chiloe	1 432.0	6 210	0	12 642	4	18 856
Chile - Concepcion	880.7	617	0	0	0	617
Chile - Valparaiso	543.0	384	0	0	0	384
Chile - La Serena	846.2	291	0	0	0	291
Chile - Antofagasta	582.8	31	2	0	0	33
Chile - Arica	583.6	59	0	0	0	59
Peru - Mollendo	683.9	79	1	1	0	81
Peru - Lima	792.7	620	156	170	42	988
Peru - Chimbote	426.1	65	0	0	0	65
Peru - Chiclayo	871.6	169	431	0	500	1 100
Ecuador	1 385.5	562	3 384	0	60	4 006
Colombia - Pacific	746.9	320	679	0	0	999
Regional total (Pacific Coast)	9 775.0	9 407	4 653	12 813	606	27 479
Total	27 929.6	24 874	44 370	45 529	6 539	121 317

3.2.4. Black-bellied Plover *Pluvialis squatarola*

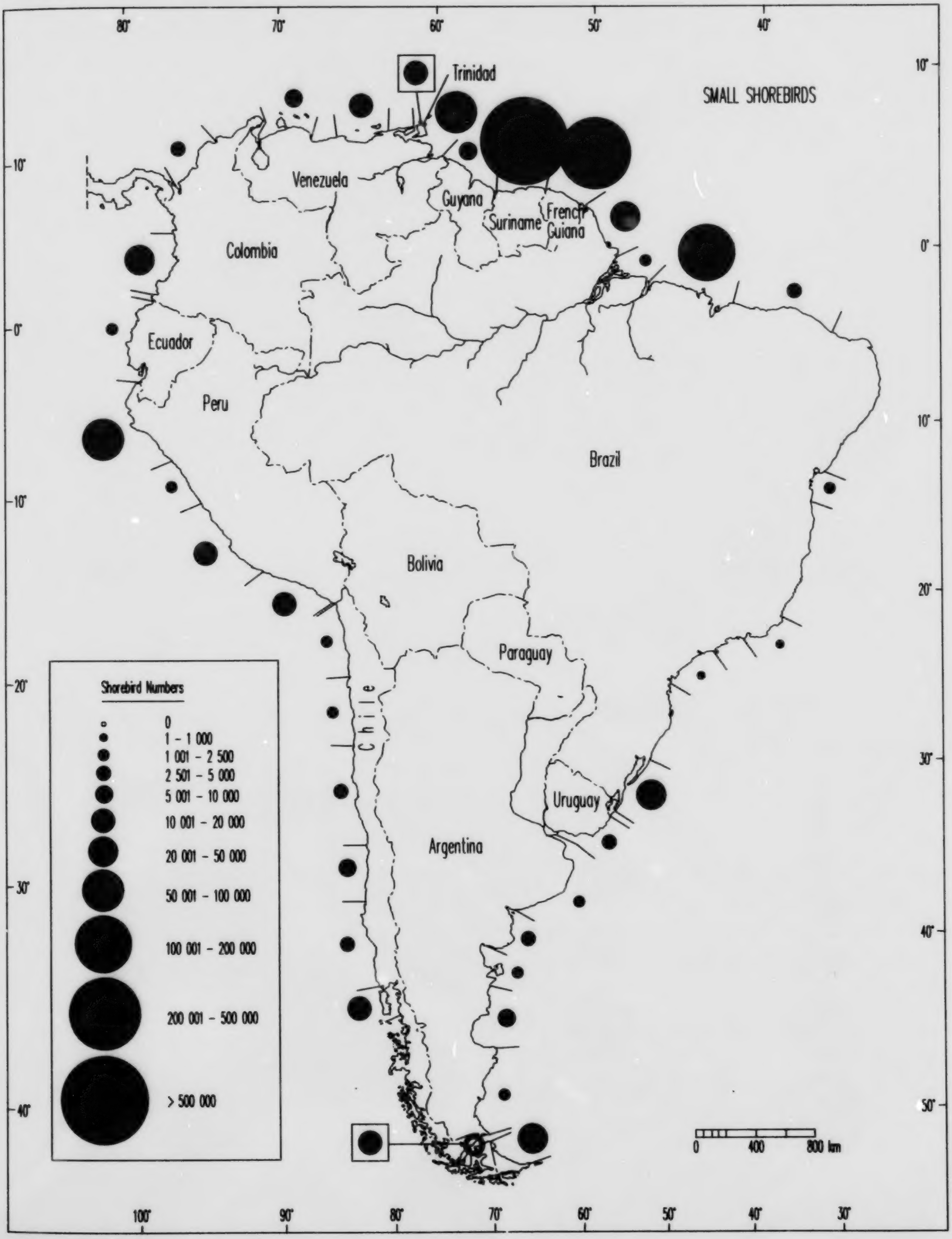
The main wintering grounds of the Black-bellied Plover are found along the tropical coastlines of the northern half of South America, particularly along the north coast (Map 3.4). Of the total of 27 300 birds counted on the surveys, 87.2% were on the north coast of the continent, with the Pacific coast holding 10.5% and the Atlantic coast 2.3%.

The north-central coast of Brazil between Belem and Sao Luis was the most important wintering area, with 14 700 birds, some 61.9% of the North Coast total or 54.0% of the South American total. This highly indented coastline consists of bays and headlands with extensive mud- and sandflats, mangroves, and beaches, providing abundant feeding and roosting habitats for this species. The coastline is very long; over 2500 km of coastline were surveyed. The overall eco-unit density was six birds per kilometre, with densities in individual sectors up to 26 birds per kilometre. Suriname was the next most important area, holding 16.6% of the regional total (14.5% of the South American total). The Suriname coast is considerably straighter, consisting of very extensive mudflats alternating with stretches of beach/tough mudbanks: the overall eco-unit density was 10.7 birds per kilometre, with individual sector densities up to 49 birds per kilometre; most sector densities did not exceed 20 birds per kilometre.

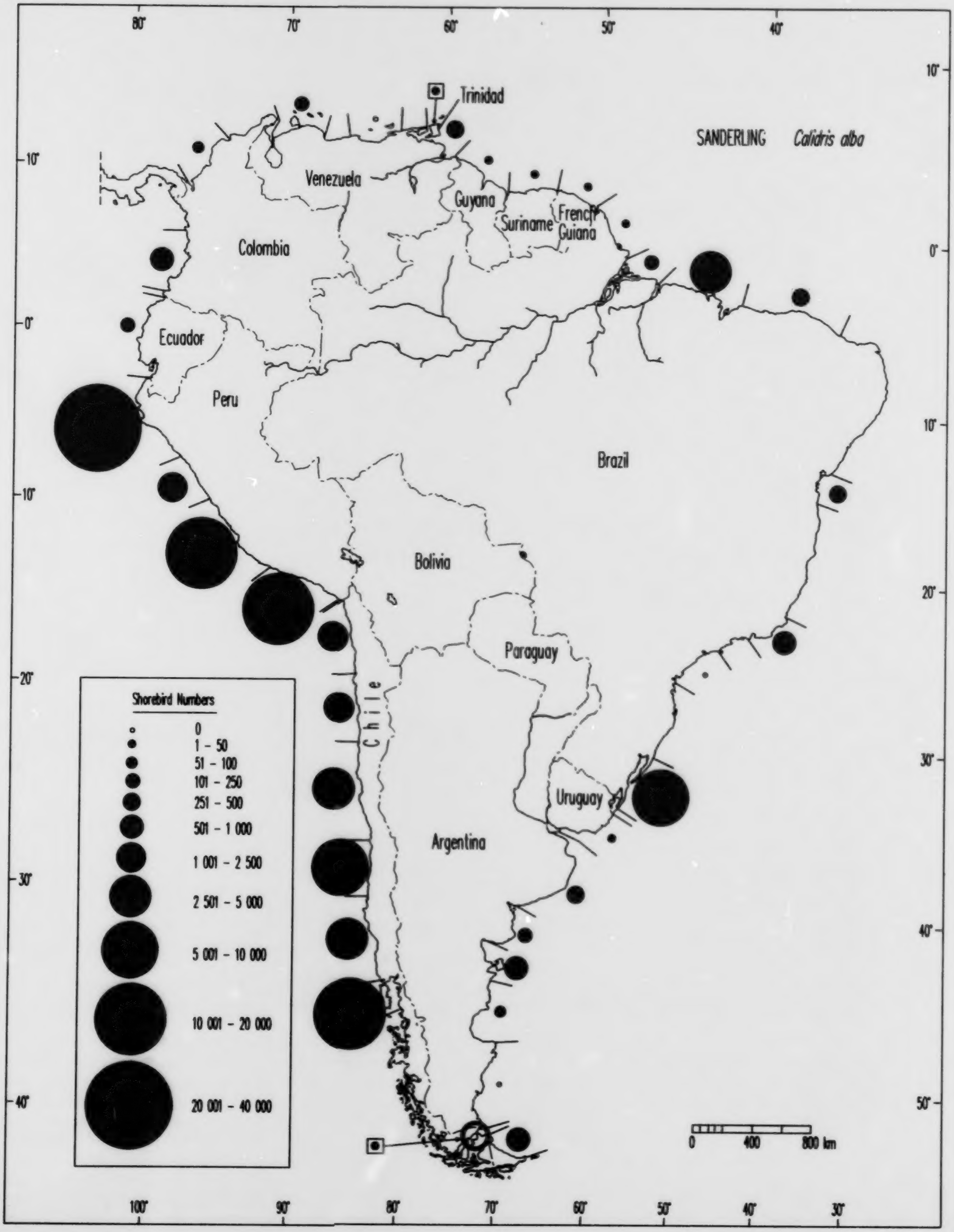
Other significant areas included parts of the Caribbean coast of Colombia (1200 birds, 5.2 and 4.6% of North Coast and South American totals, respectively) and the northeast coast of Brazil (1300 birds, 5.4 and 4.7% as above). In Colombia, the majority of birds were found in shallow lagoon areas adjacent to the shoreline, especially those near the exit of the Rio Magdalena near Barranquilla. In northeast Brazil, the birds were generally found along ocean beaches with beachrock, particularly between Sao Luis and Parnaiba.

On the Pacific side, the species was found principally in Peru, Ecuador, and Colombia; only scattered individuals were found south of the Chile/Peru border area in Chile. The most southerly records (two birds) on the surveys were near the Rio Mataquito in the Valparaiso

Map 3.1
Distribution of small shorebirds on the coast of South America

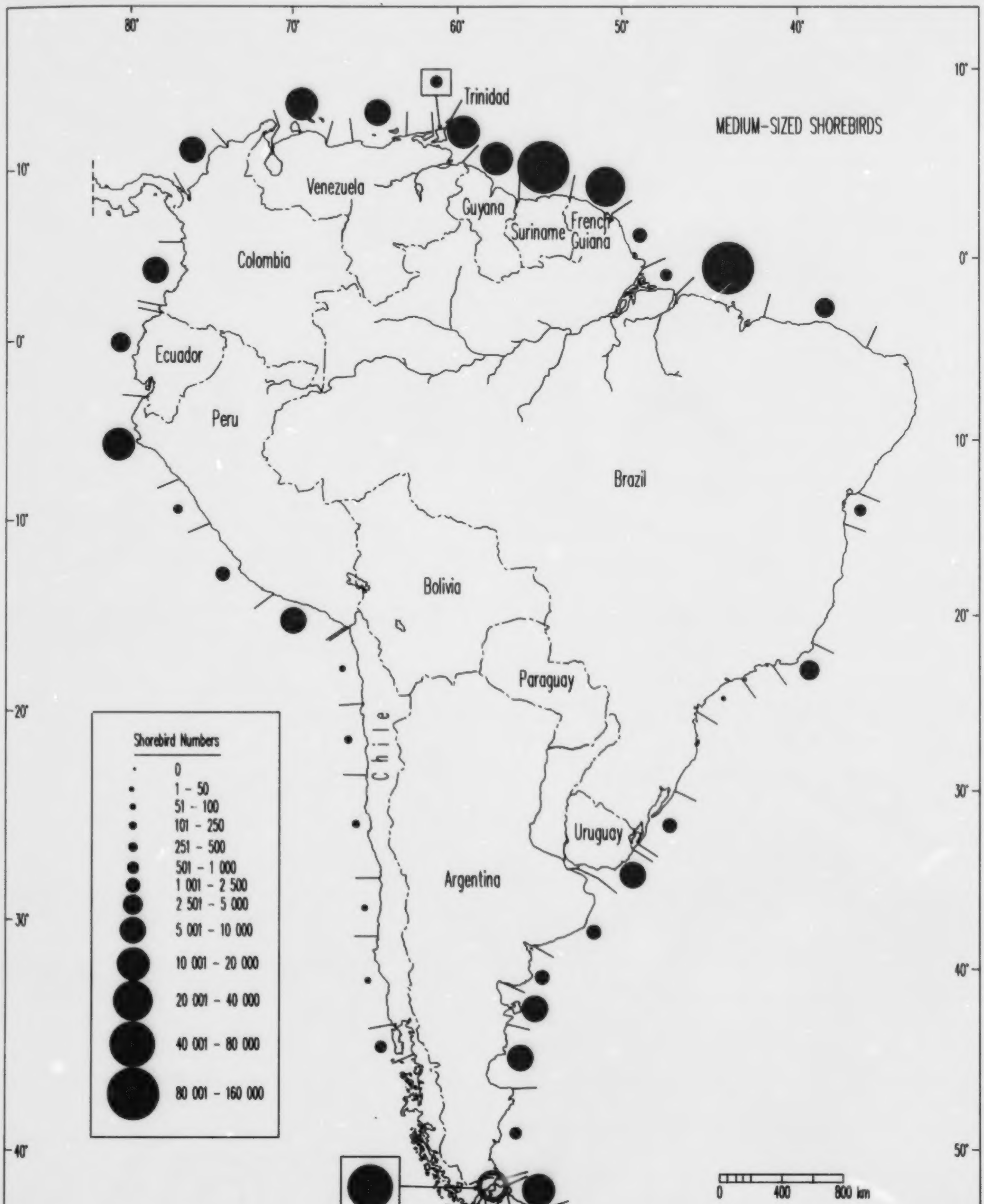

SMALL SHOREBIRDS
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 50 000
50 001 - 100 000
100 001 - 200 000
200 001 - 500 000
> 500 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Map 3.2
Distribution of Sanderlings *Calidris alba* on the coast of South America

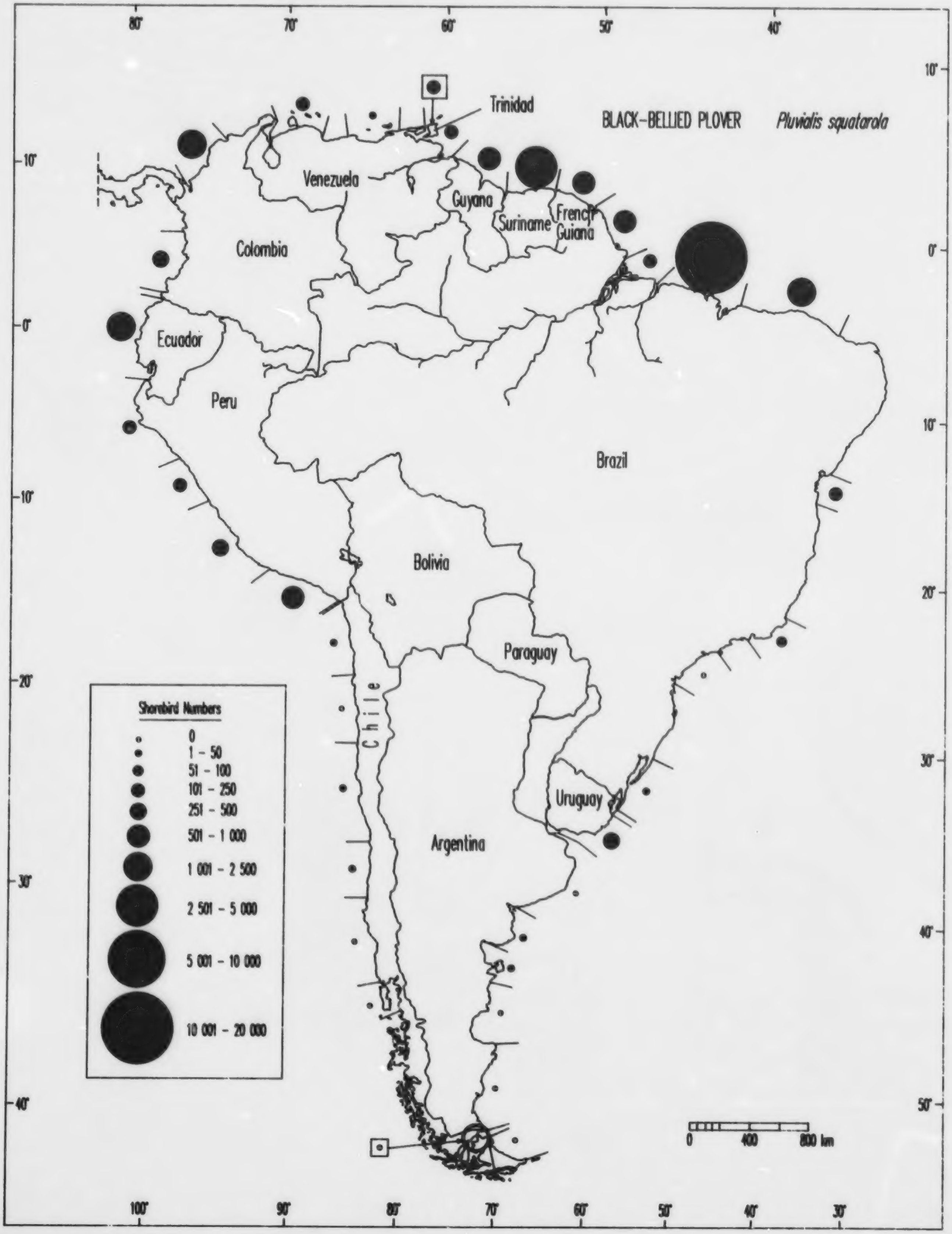


SANDERLING *Calidris alba*
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Map 3.3
Distribution of medium-sized shorebirds on the coast of South America


MEDIUM-SIZED SHOREBIRDS
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
80 001 - 160 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Map 3.4
Distribution of Black-bellied Plovers *Pluvialis squatarola* on the coast of South America


BLACK-BELLIED PLOVER *Pluvialis squatarola*
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
30°

eco-unit. In Peru, where only 1300 birds were counted (46.8% of the Pacific Coast total, 4.9% of the South American total), many Black-bellied Plovers were found in the widely separated coastal wetlands occurring along the coast. In the southern part of the country, the species occurred in coastal wetlands near the mouths of the Rio Camana (235) and the Rio Locumba (120) and at the Mejia Lagoons (110). Nearly all other observations in central and northern Peru involved birds in coastal wetlands or along beaches near such wetlands (e.g., Rio de Huaura, Paramonga, Bahia de Sechura). One of the largest groups seen was of 260 birds in the bay at Paracas, within the National Reserve.

In Ecuador, Black-bellied Plovers were observed principally around the coastlines of the Gulf of Guayaquil. Most were found around the outer coastlines of the gulf, where there was a mixture of intertidal flats and sandy habitats, rather than in the inner, muddier, mangrove-lined parts. Favoured habitats were found north of the border with Peru, along the southeast corner of the Isla de Puna and at the northwestern entrance to the bay. The species was most common in similar habitats in southern Colombia between Tumaco and Buenaventura.

Few (620, 2.3% of the South American total) Black-bellied Plovers were observed on surveys on the Atlantic coast. Very few indeed were seen south of Uruguay in Argentina — a few on the estuary near Bahia Blanca and on the coast near the San Antonio Oeste estuary. The largest concentration was at the Laguna de Rocha, an extensive brackish lagoon adjacent to the Uruguayan coastline. Small numbers were found along beach coastline north of Rio de Janeiro, where small ponds and lagoons occurred behind the shore, and in the Baia de Todos os Santos near Salvador. The species was also noted in smaller numbers in the muddier, mangrove-lined estuaries south of Salvador near Valenca and Itubera.

3.2.5. Ruddy Turnstone *Arenaria interpres*

Ruddy Turnstones were widely distributed in South America, being observed in small numbers south to Tierra del Fuego. They were most numerous on the north coast of the continent and fairly common on the beaches of the Pacific coast (Map 3.5). Of the total of 23 500 counted on the surveys, 86.2% occurred on the north coast, 10.0% on the Pacific coast, and only 3.8% on the Atlantic coast.

By far the most important area for Ruddy Turnstones was the north-central coast of Brazil between Belem and Sao Luis, where over 17 900 birds were counted, representing 76.2% of the South American total (88.5% of the North Coast total). This long, indented coastline contained an abundance of tough mudbanks, a habitat much favoured by turnstones. Other important areas included Suriname (2.6 and 3.1% of the South American and North Coast totals, respectively) and French Guiana (2.6 and 3.0% as above), as well as the northeast coast of Brazil (1.8 and 2.1% as above). In the Guianas, tough mudbanks and beaches were favoured habitats; in northeast Brazil, ocean beaches with beachrock were preferred.

On the Pacific coast, most of the 2400 birds recorded were found in Peru (81.1% of the Pacific Coast total, or 8.1% of the South American total). Birds were most numerous in sectors containing sand or gravel beaches, with either river entrances, pools, wetlands, or agricultural land adjacent to the shore. In Ecuador and Colombia, turnstones were usually found on coasts with sandy beaches near inlets or areas with large intertidal flats.

Densities of turnstones were generally also highest on the north-central coast of Brazil, with a number of sectors showing densities in the range 10 to 20 birds per kilometre over distances of 60–124 km, with a highest value of 31 birds per kilometre. Densities in the Guianas, the next most important area, were generally lower, not often exceeding one bird per kilometre, with highest recorded values of nine birds per kilometre in Suriname and 13 birds per kilometre in French Guiana. Densities were also low on the Pacific coast: in Peru they rarely exceeded one bird per kilometre, with a highest recorded value of 12 birds per kilometre along the beaches near the Sechura Desert in northern Peru.

3.2.6. Yellowlegs *Tringa* spp.

Yellowlegs were widely distributed in South America (Map 3.6), although they were most heavily concentrated on the north coast of the continent, with the major wintering areas centred on the Guianas. Owing to the difficulty of separating the two species involved — Greater Yellowlegs *T. melanoleuca* and Lesser Yellowlegs *T. flavipes* — from the air, totals for the two were combined. Over 91 000 yellowlegs were observed on the surveys — 90.7% on the north coast, 6.7% on the Atlantic coast, and 2.6% on the Pacific side of the continent.

The major coastal wintering areas for yellowlegs were clearly in the Guianas. Between them, the three countries supported 78 000 birds, representing 85.9% of the total for South America. Suriname was individually the most important region, with 72.8% of the South American total; Guyana held 7.5%, and French Guiana 5.6%. Yellowlegs were particularly common in areas with extensive intertidal mudflats or in adjacent open lagoons, habitats very abundant in the Guianas, especially in Suriname. Similar habitats in the east of Guyana and west of French Guiana were heavily used. Elsewhere on the north coast, yellowlegs occurred mostly in lagoon habitats adjacent to the shore, such as the Campuchano Lagoons in western Venezuela, the Piritu Lagoon and lagoons west of Barcelona in central Venezuela, and the Caroni Swamp in Trinidad.

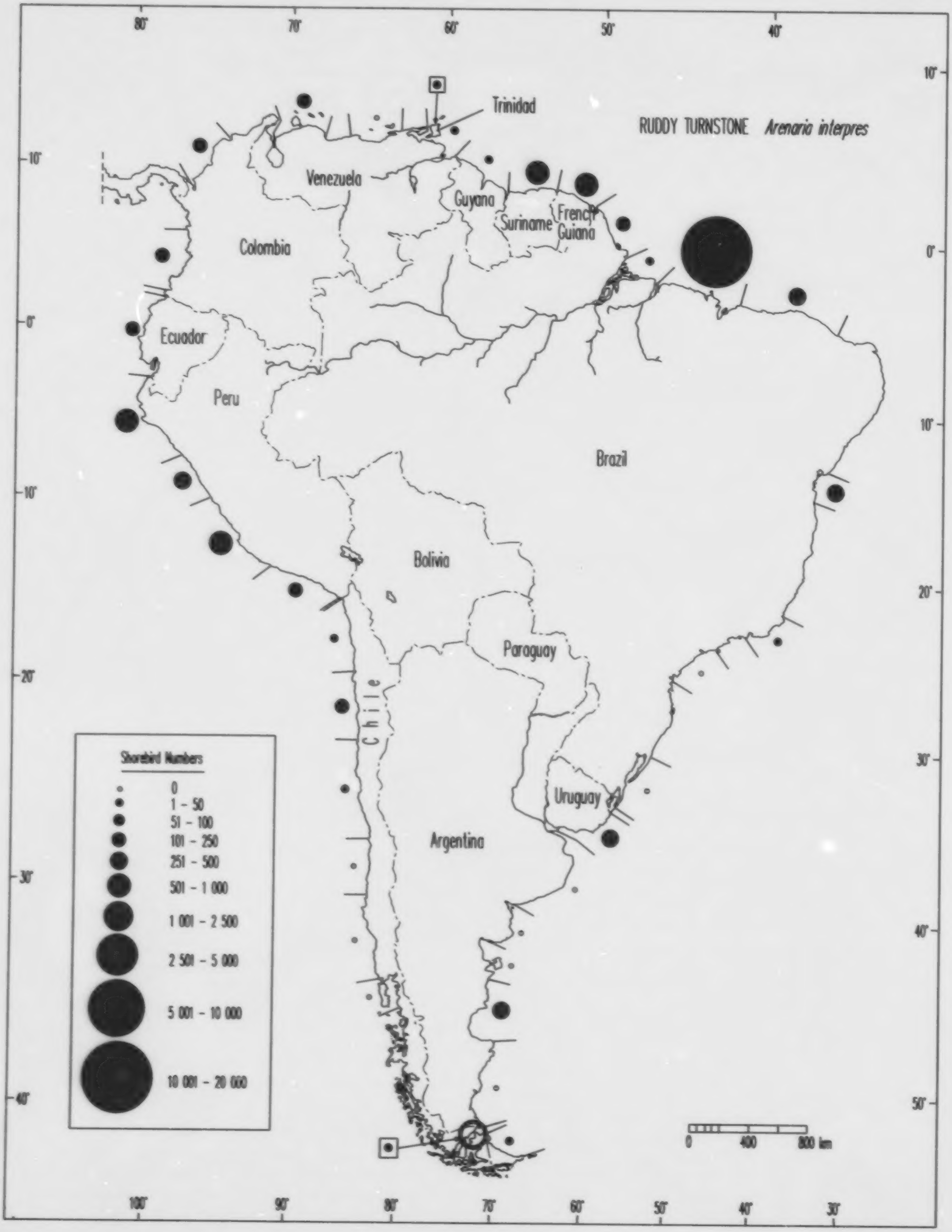
On the Atlantic coast, the largest numbers occurred in shallow, wet areas behind the coast between Cabo de Sao Tome and Atafona east of the Lagoa Feia in the Rio eco-unit in Brazil. Lagoon shorelines not far from the coast were also used in southern Brazil, including the shorelines of the Lagoa dos Patos and smaller lagoons nearby, in Uruguay (Laguna de Rocha), and on the coast of Buenos Aires province in Argentina (Laguna Mar Chiquita and Laguna Salada). However, the major concentrations in Argentina were on the coastal marshes of the Bahia Samborombon.

On the Pacific side, coastal lagoons and marshes or wetlands associated with river mouths were again the most important habitats. In Peru, for instance, the largest numbers were found in the Rio Camana wetlands (900), the lagoons north of Eten (450), and the mouth of and wetlands near the Rio Pisco (340). Relatively large numbers also occurred on the mudflats in the Paracas Reserve.

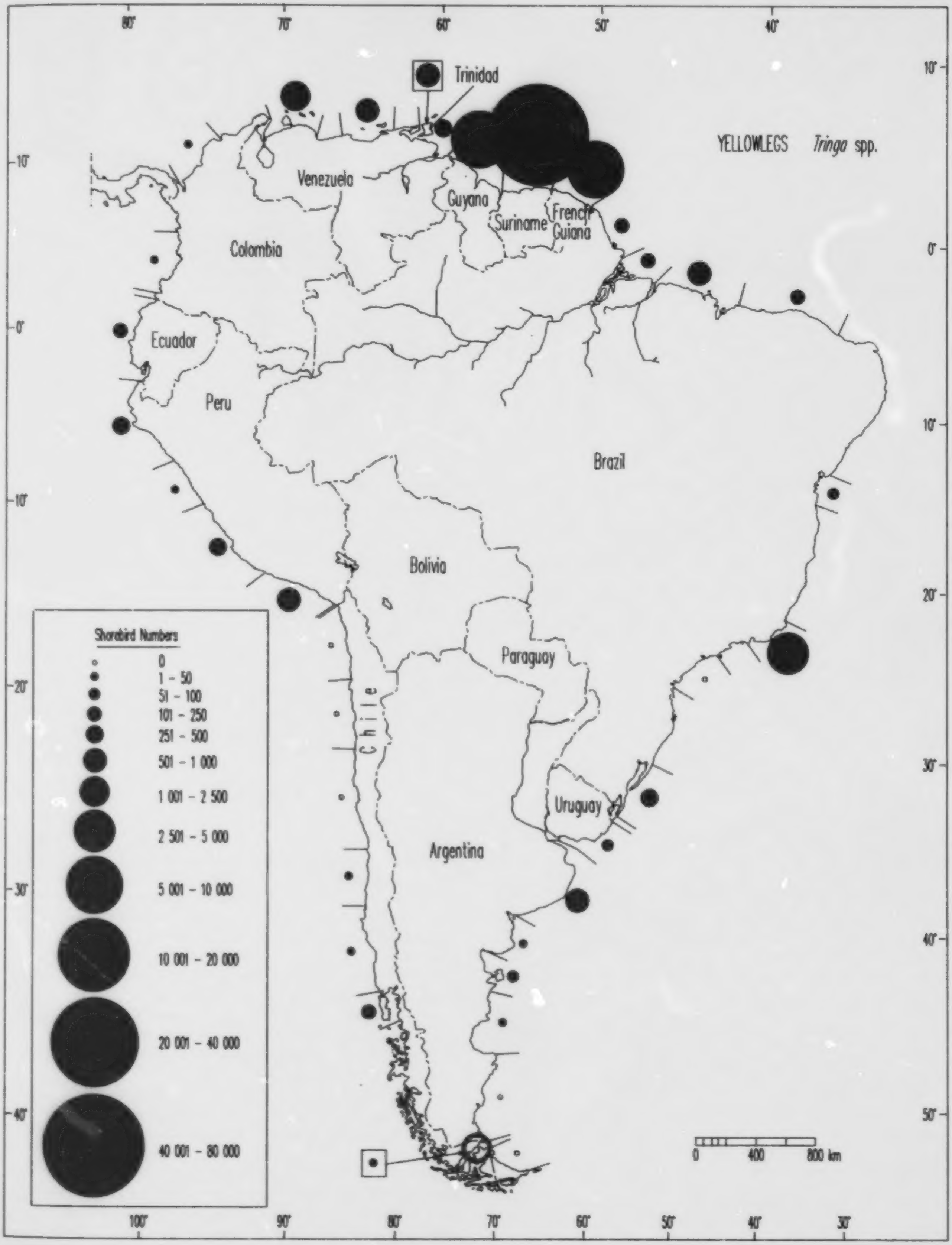
3.2.7. Red Knot *Calidris canutus*

The major wintering grounds of the Red Knot were in Tierra del Fuego and along the coastlines of Patagonia in Argentina (Map 3.7). Few major concentrations were seen elsewhere: small numbers occurred in north-central

Map 3.5
Distribution of Ruddy Turnstones *Arenaria interpres* on the coast of South America


RUDDY TURNSTONE *Arenaria interpres*
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Map 3.6
Distribution of yellowlegs *Tringa* spp. on the coast of South America


YELLOWLEGS *Tringa* spp.
Trinidad
Venezuela
Colombia
Guyana
Suriname
French Guiana
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
400
800 km
80°
70°
60°
50°
40°
30°
90°
100°
10°
0°
20°

Brazil and in western Venezuela, and there were a few scattered observations elsewhere along the north coast of Brazil.

By far the most important individual site discovered was Bahia Lomas, situated near the eastern mouth of the Strait of Magellan on the north coast of the Chilean sector of Tierra del Fuego. The bay contains a vast area of both smooth and channelled mudflats backed by flat grasslands, and in late January 1985 it held 41 700 knots, or 54.6% of the South American total. Other important concentrations involved 5100 birds near Rio Grande and 4440 in the vicinity of Bahia San Sebastian on the Argentinian coast of Tierra del Fuego. Knots at Rio Grande foraged on the extensive areas of rocky *restingas* exposed by the tides and roosted on the shingle spit at Punta Popper or on the beach at Rio Grande. Birds at Bahia San Sebastian made use of the vast channelled mudflats in the bay and long shingle spit running along the coast. Altogether, the Chilean sector of Tierra del Fuego held nearly 42 800 knots and the Argentinian sector some 10 500, representing 56.0 and 13.7%, respectively, or a combined 69.7% of the South American total.

Other significant wintering flocks were found along the Patagonian shores of Argentina around Golfo San Jorge and the Peninsula Valdes. The Golfo San Jorge eco-unit contained 8700 knots (11.4% of the South American total), with significant numbers in the area of Bahia Bustamante (7400), in particular, and along the *restingas* south of Commodoro Rivadavia between Caleta Olivia and Cabo Blanco (1300). The Peninsula Valdes was another focal point, the eco-unit containing over 5000 knots (6.6% of the South American total). Flocks were observed in a number of locations around the peninsula—1200 to the north near Puerto Lobos on the shores of Golfo San Matias, 1000 near Caleta Valdes, 2000 near Punta Delgada, and 300 and 500 near the entrance to Golfo Nuevo. Golfo San Jose on the north side of the peninsula is known to be an important stopover point during northward migration (Harrington 1982; Morrison 1984); however, it was not covered on the surveys for logistical reasons. Smaller concentrations of knots were found farther south on the Patagonian coast, south of Puerto Deseado near Punta Medanosa (400) and Cabo Danaso (150). All of the 67 500 knots wintering on the Atlantic coast were found between Tierra del Fuego and the Rio Colorado, Argentina, and represented 88.4% of the South American total for the species.

The remaining 11.6% were observed on the north coast of the continent. Most occurred on the north-central coast of Brazil, where 8200 birds were identified as knots (10.7% of the South American total), occurring principally in two flocks of 5000 and 3000, respectively, in the area of Sao Luis. This is a very productive region, the indented coastline providing a wide variety of muddy and sandy feeding and roosting habitats, and is important for a range of species, particularly medium-sized and large ones. The only other notable concentration (520) was observed in western Venezuela at the mouth of Lake Maracaibo near the shores of the Gulf of Venezuela.

No knots were identified on the Pacific coast of South America during the aerial surveys, although small numbers have been observed on ground surveys on this coast (unpubl. results; e.g., Hughes 1976).

3.2.8. Dowitchers *Limnodromus* spp.

Although it would not be possible to distinguish the two species of dowitchers from the air, very few, if any, Long-billed Dowitchers *L. scolopaceus* are thought to reach South America (Blake 1977), so that all observations of dowitchers made on the surveys are likely to be of Short-billed Dowitchers *L. griseus*.

Dowitchers were clearly restricted to the northern part of the continent, especially the north coast, where 97.1% of the total of some 49 000 were observed (Map 3.8). The remaining 2.9% occurred on the Pacific coast, south only as far as Ecuador: none was recorded farther south on the Pacific coast, and the species was not recorded on the Atlantic coast.

Dowitchers were observed principally on mangrove coasts with extensive tidal flats or in coastal lagoons. They were especially concentrated in such habitats in Suriname, where 44.7% of the South American total occurred. Similar habitats in neighbouring Guyana (5.9%) and French Guiana (4.9%) also held significant concentrations. The second most important region in South America was the north-central coast of Brazil between Belem and Sao Luis, where 8100 birds (16.6%) were found on the mangroves and intertidal flats of this heavily indented coastline. The lagoons of the central coast of Venezuela, such as those west of Barcelona and especially Chacopata Lagoon, also held substantial numbers (7100, 14.6%). A similar pattern was observed elsewhere, with the species being found on mangrove coasts in the Orinoco delta (3100, 6.3%), lagoons of the Caribbean coast of Colombia (1600, 3.2%), and mangrove coasts or inlets on the Pacific coast of Colombia (600, 1.2%) and in Ecuador (830, 1.7%).

3.2.9. Large shorebirds

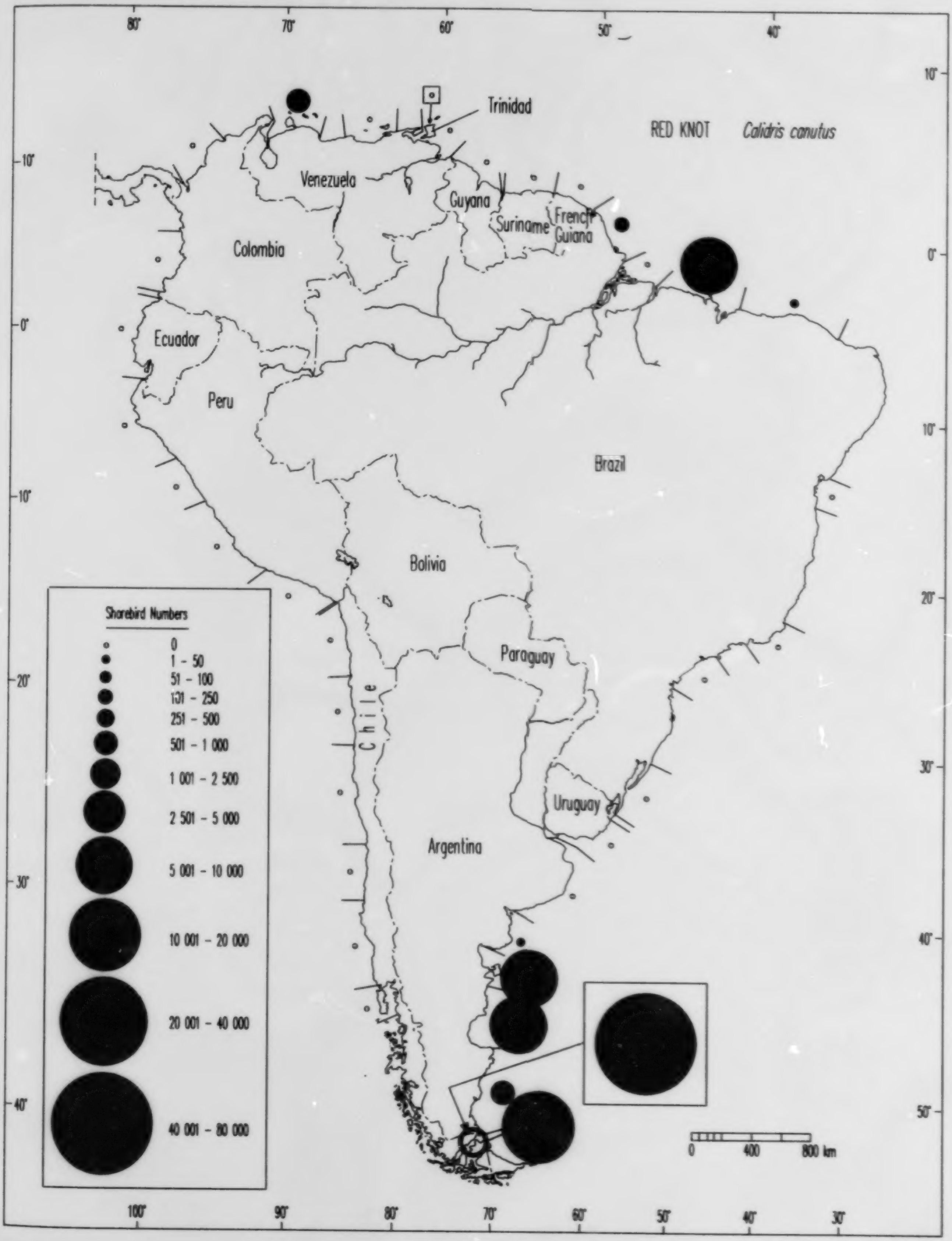
More than 121 000 large shorebirds were counted on the surveys, making up some 4.2% of the grand total of 2.9 million Nearctic shorebirds (Table 3.2). Several centres of distribution were found—in Suriname, on the north-central coast of Brazil, in Tierra del Fuego, and in the Chiloe area—and these tended to reflect the distribution of different species (Map 3.9).

3.2.10. Willet *Catoptrophorus semipalmatus*

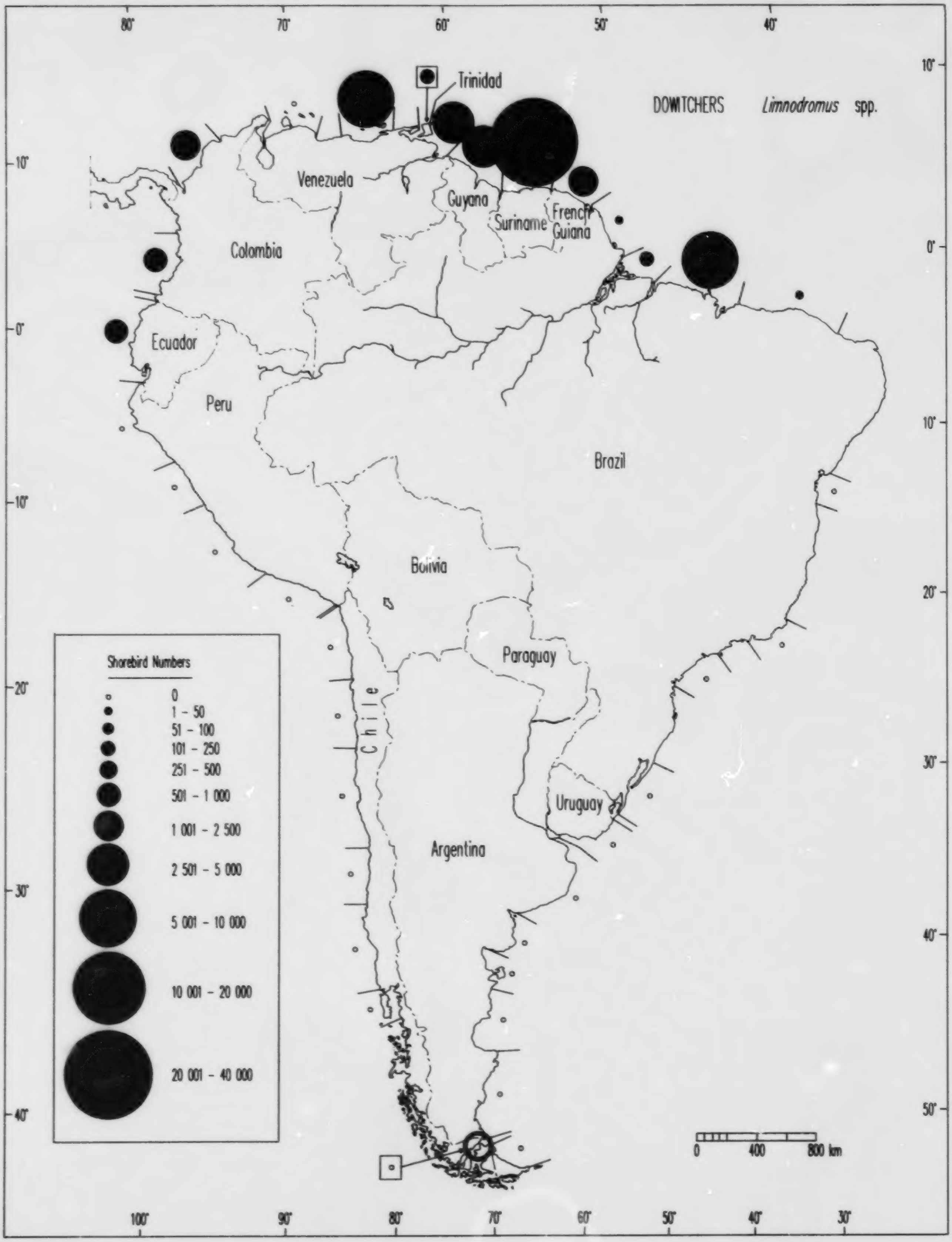
The major wintering areas for Willets in South America were on the north coast of the continent, where 89.3% of the total of 44 400 were observed (Map 3.10). Willets were associated with mangrove coastlines with extensive intertidal areas and tough mudflats and mudbanks. Such habitats were abundant on the long, highly indented coastline of north-central Brazil, which was the most important region for the species, holding approximately half (49.3%) of the South American total. Suriname, which also contained extensive areas of such habitats, was second in importance, with 35.3%. Willets were scattered along most of the rest of the north coast in smaller numbers, although none was observed in the mouth of the Amazon River (Table 3.3).

The distribution of mangroves effectively limited the distribution of Willets on both Atlantic and Pacific coasts, although a few birds straggled south on the coasts of Peru and northern Chile. On the Pacific coast of Colombia, Willets were found in mangrove inlets (1.5%), particularly between Buenaventura Bay and the border with Ecuador. In Ecuador (3400, 7.6%), most birds were found either on the mangrove coasts of the Gulf of

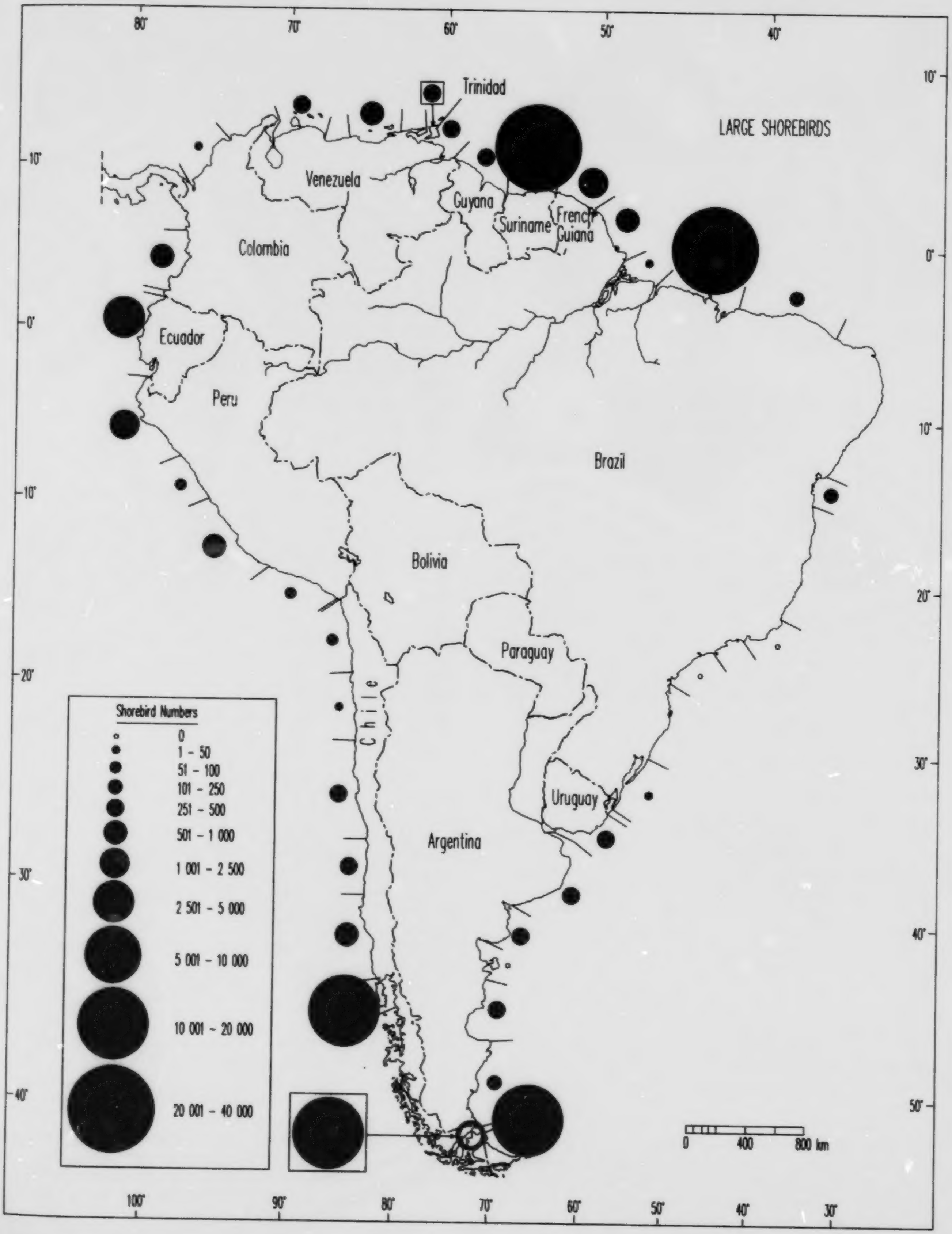
Map 3.7
Distribution of Red Knots *Calidris canutus* on the coast of South America


RED KNOT *Calidris canutus*
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Map 3.8
Distribution of dowitchers *Limnodromus* spp. on the coast of South America


DOWITCHERS *Limnodromus* spp.
Trinidad
Venezuela
Colombia
Guyana
Suriname
French Guiana
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Map 3.9
Distribution of large shorebirds on the coast of South America


LARGE SHOREBIRDS
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Guayaquil (1900) or in inlets with mangrove complexes, such as the Bahia de Caraquez (1200). Most of the birds recorded in Peru (590, 1.3%) were found in the north in mangroves (Tumbes, 22), wetland complexes (Sechura, 170), or estuaries (Virrila, 200), although a few straggled south along beach coastlines, often where streams or wetlands occurred, as far south as northern Chile.

On the Atlantic coast, Willets were not found south of the Salvador area, where they occurred in small numbers (80, 0.2%) on mangrove-lined bays and inlets (Baia de Todos os Santos, Valenca, Itubera).

3.2.11. Hudsonian Godwit *Limosa haemastica*

The major coastal wintering areas of Hudsonian Godwits were in the far south of the continent. Two centres of distribution were evident: the more important was in Tierra del Fuego, with areas around the island of Chiloe in southern Chile also supporting significant concentrations (Map 3.11). Of the total of over 45 500 birds counted, 71.9% were found on the Atlantic coast and 28.1% on the Pacific coast.

The most important concentrations of Hudsonian Godwits occurred in Tierra del Fuego—nearly 19 500 (42.8%) in Argentina and almost 11 700 (25.6%) in Chile. The single most important site was the Bahia San Sebastian, Argentina, on the Atlantic coast of Tierra del Fuego, where 19 400 godwits were found on the vast, channelled mudflats protected by the 18-km-long shingle spit, Peninsula El Paramo. This one site alone thus held some 42.5% of the South American total, making it an area of outstanding international importance. The remaining birds in Argentinian Tierra del Fuego were found on *restingas* along the Atlantic coast. The second most important individual site was Bahia Lomas, the major wintering grounds of the Red Knot, some 60 km to the north at the eastern mouth of the Strait of Magellan. The vast, smooth, and channelled flats of this bay held a further 10 500 birds (23.1%). The remaining birds (1140) in Chilean Tierra del Fuego were found across from the mouth of Bahia Lomas on the north shore of the Strait of Magellan.

Smaller numbers were scattered northwards along the Atlantic coast as far north as Uruguay. In the southern areas along the Patagonian coastlines of Argentina, most godwits were found on *restingas*, e.g., near Puerto Deseado (160) and southwards along the Caleta Olivia (350) south of Commodoro Rivadavia. On the northern half of the Argentinian coastline, godwits were observed on estuarine areas, e.g., on the extensive flats of Bahia Union and Bahia Anegada (310) south of the exit of the Rio Colorado, and on the flats of the southern part of the Bahia Samborombon (430) west of Punta Rasa in Buenos Aires province. In Uruguay, the birds were found principally on freshwater and brackish lagoons, including the Laguna de Rocha (215), Laguna de Castillos (50), and Lagoa Mirim (60). Although inland and lagoon habitats are used by the species in both Uruguay and Buenos Aires province (Myers and Myers 1979), the major wintering areas identified on the surveys were on the coast in the southern part of the continent.

Major wintering concentrations were also found in the Chiloe area, which held more than 12 600 (27.8% of the South American total) of the 12 800 birds recorded on the Pacific coast. The majority of the birds occurred on Chiloe Island, especially on the inlets facing the Golfo de Ancud, where sector totals ranged from 250 to about 2000 birds. Large numbers (2900) were found on similar inlets west of Puerto Montt and on a large delta east of Puerto Montt on the north shore of the Golfo de Ancud. Although many of the inlets were quite steep-sided, they often had large marshy deltas or complexes in their upper reaches, sometimes associated with mudflats, and it was on these areas that most godwits were found.

Records were very sparse elsewhere, the most notable being of 170 birds in the region of the Rio Pisco on the south-central coast of Peru.

The migration of the Hudsonian Godwit is one of the most spectacular known. As recently as the 1940s, the species was thought to be on the verge of extinction owing to the relatively small numbers that were—and still are—seen on the east coast of North America. From breeding grounds in the central Canadian Arctic, the species gathers prior to migration in large concentrations on the coasts of Hudson Bay and James Bay, as indicated by early reports of ornithologists (Hope and Shortt 1944) and confirmed by later, more extensive aerial surveys (Morrison and Harrington 1979; Morrison 1983, 1984), which have located concentrations of up to 10 000 birds in a single locality. From the James Bay coast, the birds depart on a direct flight to South America (Hagar 1966): the next area in which substantial numbers have been reported is in Buenos Aires province in Argentina, although migration schedules suggest that there is an as yet undiscovered stopover area somewhere in the northern part of South America (Morrison 1984). It thus appears likely that the wintering populations in Tierra del Fuego derive from breeding grounds in the central Canadian Arctic. Whether the populations wintering in the Chiloe region migrate to and from breeding areas in the western Arctic/Alaska has yet to be determined.

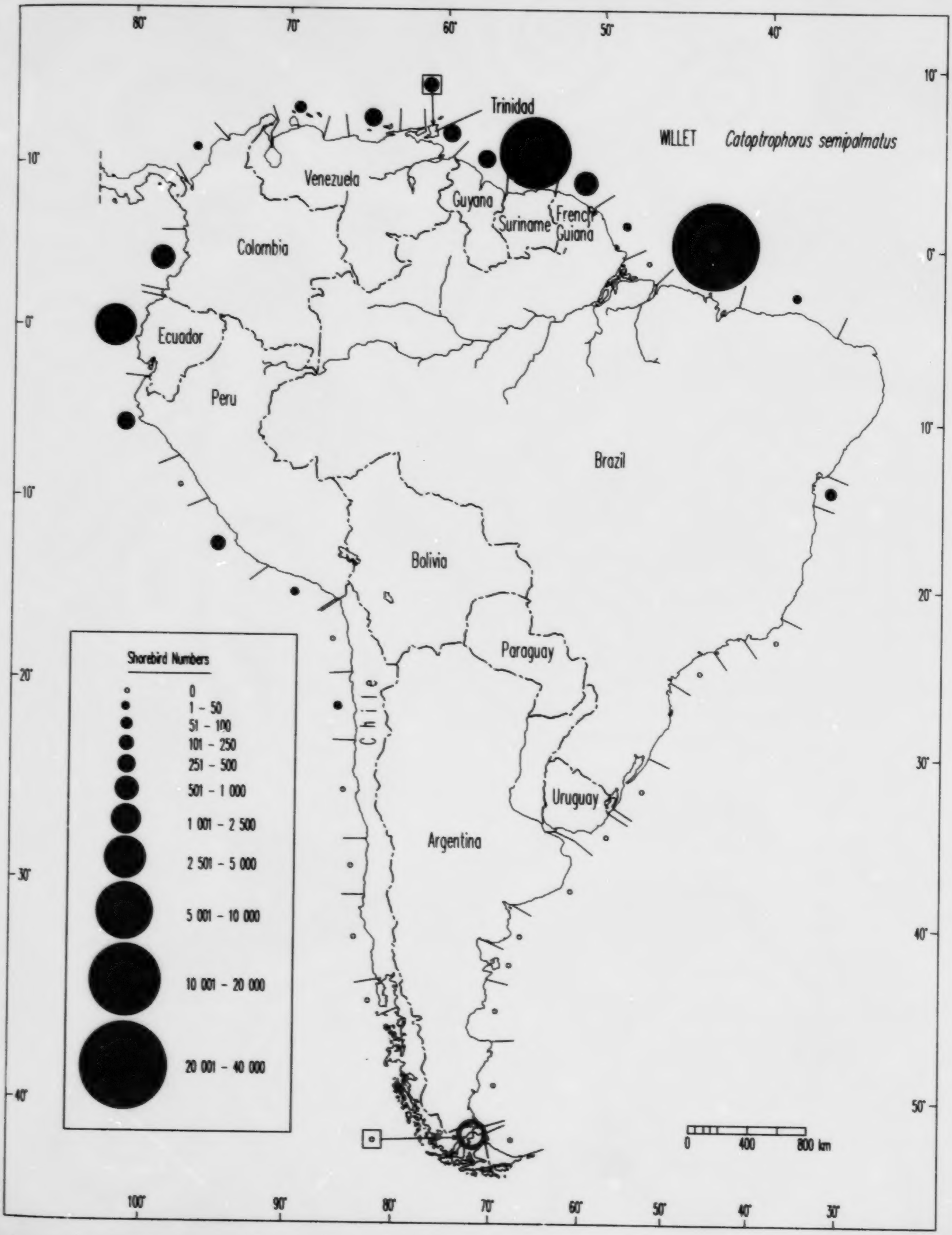
3.2.12. Whimbrel *Numenius phaeopus*

Whimbrels were rather widely distributed in South America, although three major areas of concentration were apparent from the surveys—the north-central coast of Brazil, Suriname, and Chiloe Island in Chile (Map 3.12). The majority (61.3%) of the total of 24 900 Whimbrels observed on the surveys occurred on the north coast of the continent, with substantial numbers (37.8%) on the Pacific coast and fewer (0.8%) on the Atlantic coast.

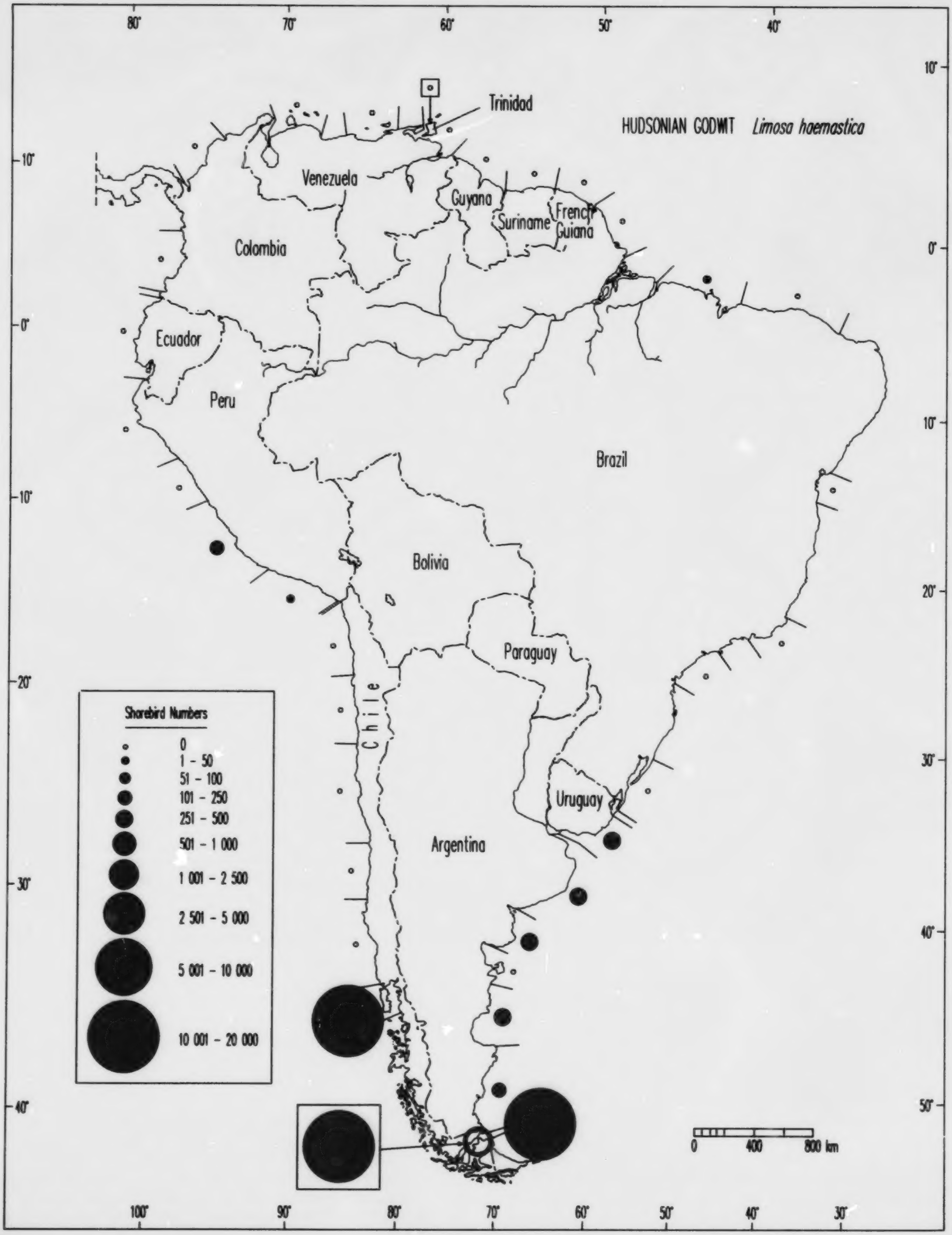
On the north coast, Whimbrels were associated with areas of extensive intertidal flats and mangroves, especially where tough mudflats and mudbanks occurred. These habitats were abundant on the north-central coast of Brazil, which held 43.7% of the South American total (71.3% of the North Coast total of 15 300), as well as in Suriname, which held 13.3% of the South American total. Whimbrels occurred in similar habitats in smaller numbers elsewhere along the north coast.

On the Pacific coast, the largest numbers were found in the Chiloe area (6200, 25.0% of the South American total). The species was widespread along the north and particularly the east coasts of the island of Chiloe in inlets facing the Golfo de Ancud—sector totals ranged from 30 to nearly 700 birds, for an overall total of more than 2800 birds. Many of the inlets running back from the coast contained small to fairly extensive marshy deltas or wetlands, sometimes with associated mudflats, and Whimbrels were found in such areas. The largest concentration in such an inlet was discovered west of Puerto Montt, with 1100 birds, and a further 740 were located in the extensive estuarine complex around Maullin.

Map 3.10
Distribution of Willets *Catoptrophorus semipalmatus* on the coast of South America

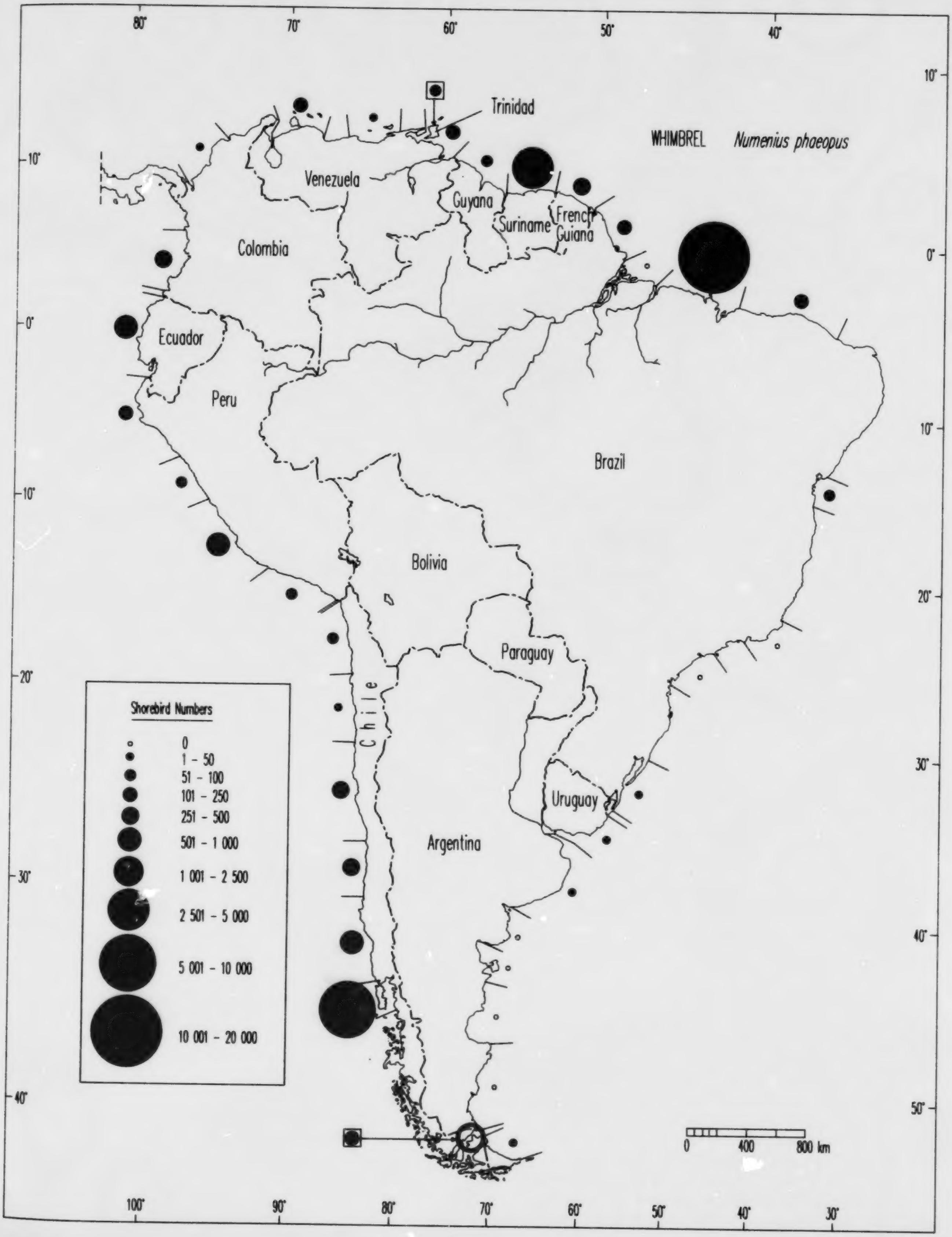

WILLET *Catoptrophorus semipalmatus*
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Map 3.11
Distribution of Hudsonian Godwits *Limosa haemastica* on the coast of South America



HUDSONIAN GODWIT *Limosa haemastica*
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°
50°
10°
0°
10°
20°
30°
40°

Map 3.12
Distribution of Whimbrels *Numenius phaeopus* on the coast of South America



WHIMBREL Numenius phaeopus
Trinidad
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Whimbrels were scattered in smaller numbers all along the Pacific coast and used a variety of habitats, principally ocean beaches northwards along the coast of Chile and through Peru (930 birds, 3.8%). In Ecuador (560 birds, 2.3%) and on the Pacific coast of Colombia (320 birds, 1.3%), Whimbrels were once again more common in mangrove coastlines with tough muddy substrates, particularly along the eastern mainland coast of the Gulf of Guayaquil and the Colombian coastline between the Ecuadorian border and Buenaventura Bay.

The small numbers on the Atlantic coast were found principally in mangrove habitats in the Salvador area in Brazil and on the bays and inlets around the Strait of Magellan in Chile.

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Chapitre 3

Aperçu

R.I.G. Morrison et R.K. Ross

3.1. Caractéristiques générales de la distribution des oiseaux de rivage en Amérique du Sud

Quelque 28 000 km du littoral de l'Amérique du Sud ont été couverts par les recensements, dont toutes les portions de la côte où l'on pensait que des habitats importants pour les oiseaux de rivage pourraient se trouver (Voir chapitre 2). Plus de 2,9 millions d'oiseaux de rivage de la région néarctique y ont été dénombrés. (Les chiffres pour les trois grandes catégories de taille sont résumés par pays au tableau 3.1.) Les espèces de petite taille prédominaient numériquement, constituant 79,7 % du total, tandis que les espèces moyennes et plus grosses en représentaient respectivement 15,7 et 4,2 %. (Voir le chapitre 2 pour la composition de chaque catégorie de taille.) Le reste, soit 0,4 % des oiseaux, n'a été classé dans aucune catégorie.

Sur le plan uniquement des nombres, la côte nord de l'Amérique du Sud était nettement la zone d'hivernage la plus importante pour les oiseaux de rivage de la région néarctique; elle en comptait près de 2,5 millions, soit 85,6 % du grand total pour l'Amérique du Sud, comparativement à quelque 218 000 (7,5 %) pour la côte du Pacifique et à environ 203 000 (7,0 %) pour la côte de l'Atlantique (Tableau 3.2). Ces résultats reflètent l'abondance des petits oiseaux de rivage sur la côte nord, mais d'autres régions étaient aussi très importantes pour d'autres groupes d'espèces ou pour des espèces particulières. Sur la côte nord, les espèces de petite taille étaient particulièrement abondantes aux Guyanes, le Surinam (57,9 %) et la Guyane française (16,9 %) en comptant ensemble environ 75 % du total pour l'Amérique du Sud; toutefois, le Brésil (10,9 %) ainsi que certaines parties du Pérou (3,9 %), du Chili (2,2 %) et de l'Argentine (1,8 %) en abritaient également de grands nombres. La côte nord était aussi importante dans le cas des oiseaux de taille moyenne : 42,2 % des oiseaux de cette catégorie recensés en Amérique du Sud se trouvaient dans les Guyanes (32,4 % au Surinam, 7,2 % en Guyane française et 2,5 % à la Guyana); des nombres élevés hivernaient également au Brésil (24,1 %), au Chili (9,7 %), au Venezuela (7,1 %), en Argentine (6,6 %) et au Pérou (5,1 %). Pour les espèces de taille plus grosse, c'est le Brésil qui en comptait le plus, avec 29,0 %, suivi du Chili (26,4 %), du Surinam (17,8 %) et de l'Argentine (17,2 %).

3.2. Distribution en Amérique du Sud des principaux groupes et espèces d'oiseaux de rivage de la région néarctique

Pour la description détaillée de la distribution des oiseaux de rivage en Amérique du Sud, nous avons divisé le littoral en 36 unités écologiques, représentant chacune une unité naturelle géographique, écologique et/ou politique, ayant un trait écologique distinctif. (Voir fig. 2.2, chapitre 2.) Les totaux pour chaque unité écologique sont résumés par catégories de taille au tableau 3.2 et par espèces aux tableaux 3.3*a–c*. Les points saillants de la distribution des oiseaux de rivage de la région néarctique pour les diverses catégories de taille et les principales espèces sont indiqués sur les cartes 3.1 à 3.12. L'emplacement des principales aires d'hivernage est indiqué au plat recto inférieur.

3.2.1. Petits oiseaux de rivage

La distribution des petits oiseaux de rivage en Amérique du Sud est présentée sur la carte 3.1. Il s'agit d'un groupe constitué principalement de petits bécasseaux du genre *Calidris* ainsi que de petits pluviers du genre *Charadrius*. Il était généralement impossible, des airs, d'identifier les membres de ce groupe, qui se ressemblent beaucoup, exception faite du Bécasseau sanderling, *Calidris alba*, que l'on pouvait compter séparément en raison de son apparence particulière et de sa présence caractéristique sur les plages océaniques (voir section 3.2.2). Les Chevaliers branlequeue (aussi appelés Maubèches branle-queue), *Actitis macularia*, étaient identifiables sur les côtes à mangroves aux endroits où la densité des oiseaux était faible, mais leur dénombrement devenait trop difficile lorsqu'ils formaient des groupes plus nombreux avec d'autres espèces.

Si ces facteurs ont pu nuire à l'identification des espèces, il reste que les observations aériennes et au sol ont indiqué qu'ordinairement les plus gros groupes de petits bécasseaux observés dans différentes régions du continent étaient constitués principalement d'individus d'une seule espèce. Sur la côte nord, le Bécasseau semipalmé, *Calidris pusilla*, dominait, tandis que dans la partie sud de la côte Atlantique, depuis la partie sud du Brésil jusqu'à la Terre de Feu, c'était le Bécasseau à croupion blanc, *C. fuscicollis*. Les indications de la carte 3.1 pour ces deux régions peuvent donc être considérées comme représentatives des distributions côtières de ces deux espèces en Amérique du Sud.

La carte 3.1 fait ressortir un certain nombre de caractéristiques générales. On peut constater que la région

Tableau 3.1
Nombres totaux d'oiseaux de rivage de la région néarctique dénombrés dans chaque pays au cours des recensements aériens sur la côte de l'Amérique du Sud de 1982 à 1986

Pays/Paramètre	Étendue couverte (km)	Petits oiseaux de rivage	Oiseaux de rivage de taille moyenne	Gros oiseaux de rivage	Oiseaux de rivage non classés	Total
Venezuela	1 938,0					
N^{bre} d'oiseaux		94 476	32 473	1 405	1 411	129 765
Proportion (%) du total pour la catégorie de taille (continent)		4,06	7,10	1,16	10,77	4,45
Proportion (%) du grand total (continent)		3,24	1,11	0,05	0,05	4,45
Trinité	483,8					
N^{bre} d'oiseaux		12 393	986	259	0	13 638
Proportion (%) du total pour la catégorie de taille (continent)		0,53	0,22	0,21	0,00	0,47
Proportion (%) du grand total (continent)		0,42	0,03	0,01	0,00	0,47
Guyana	478,5					
N^{bre} d'oiseaux		9 808	11 618	340	0	21 766
Proportion (%) du total pour la catégorie de taille (continent)		0,42	2,54	0,28	0,00	0,75
Proportion (%) du grand total (continent)		0,34	0,40	0,01	0,00	0,75
Surinam	369,8					
N^{bre} d'oiseaux		1 346 625	148 168	21 536	10 000	1 526 329
Proportion (%) du total pour la catégorie de taille (continent)		57,85	32,42	17,75	76,31	52,28
Proportion (%) du grand total (continent)		46,13	5,08	0,74	0,34	52,28
Guyane française	388,2					
N^{bre} d'oiseaux		394 334	32 906	2 094	1 500	430 834
Proportion (%) du total pour la catégorie de taille (continent)		16,94	7,20	1,73	11,45	14,76
Proportion (%) du grand total (continent)		13,51	1,13	0,07	0,05	14,76
Brésil	7 852,5					
N^{bre} d'oiseaux		252 812	110 258	35 147	0	398 217
Proportion (%) du total pour la catégorie de taille (continent)		10,86	24,12	28,97	0,00	13,64
Proportion (%) du grand total (continent)		8,66	3,78	1,20	0,00	13,64
Uruguay	621,9					
N^{bre} d'oiseaux		3 137	6 960	422	0	10 519
Proportion (%) du total pour la catégorie de taille (continent)		0,13	1,52	0,35	0,00	0,36
Proportion (%) du grand total (continent)		0,11	0,24	1,01	0,00	0,36
Argentine	4 549,0					
N^{bre} d'oiseaux		41 429	30 195	20 806	194	92 624
Proportion (%) du total pour la catégorie de taille (continent)		1,78	6,61	17,55	1,48	3,17
Proportion (%) du grand total (continent)		1,42	1,03	0,71	0,01	3,17
Chili	5 487,5					
N^{bre} d'oiseaux		51 186	44 432	32 019	0	127 637
Proportion (%) du total pour la catégorie de taille (continent)		2,20	9,72	26,39	0,00	4,37
Proportion (%) du grand total (continent)		1,75	1,52	1,10	0,00	4,37
Pérou	2 774,3					
N^{bre} d'oiseaux		89 675	23 367	2 234	0	115 276
Proportion (%) du total pour la catégorie de taille (continent)		3,85	5,11	1,84	0,00	3,95
Proportion (%) du grand total (continent)		3,07	0,80	0,08	0,00	3,95
Équateur	1 385,5					
N^{bre} d'oiseaux		2 274	3 485	4 006	0	9 765
Proportion (%) du total pour la catégorie de taille (continent)		0,10	0,76	3,30	0,00	0,33
Proportion (%) du grand total (continent)		0,08	0,12	0,14	0,00	0,33
Colombie	1 600,6					
N^{bre} d'oiseaux		29 673	12 238	1 049	0	42 960
Proportion (%) du total pour la catégorie de taille (continent)		1,27	2,68	0,86	0,00	1,47
Proportion (%) du grand total (continent)		1,02	0,42	0,04	0,00	1,47
Total	27 929,6	2 327 822	457 086	121 317	13 105	2 919 330
Proportion (%) du grand total (continent)		79,74	15,66	4,16	0,45	100,00

Tableau 3.2
Nombres totaux par catégories de taille des oiseaux de rivage de la région néarctique recensés dans chaque région et chaque unité écologique de la côte de l'Amérique du Sud

Région/Unité écologique	Étendue de l'unité écologique (km)	Petits oiseaux de rivage	Oiseaux de rivage de taille moyenne	Gros oiseaux de rivage	Oiseaux de rivage non classés	Total
Côte nord						
Colombie - Côte caraïbe	853,7	4 955	6 014	50	0	11 019
Venezuela - Côte caraïbe occidentale	1 113,2	9 640	10 205	406	1 411	21 662
Venezuela - Côte caraïbe centrale	275,6	15 263	8 240	519	0	23 962
Venezuela - Orénoque	549,2	69 633	14 028	480	0	84 141
Trinité	483,8	12 393	986	259	0	13 638
Guyana	478,5	9 808	11 618	340	0	21 766
Surinam	369,8	1 346 625	148 168	21 536	10 000	1 526 329
Guyane française	388,2	394 334	32 906	2 094	1 500	430 834
Brésil - Nord	464,3	25 598	2 323	674	0	28 595
Brésil - Amazone	633,8	2 080	621	7	0	2 708
Brésil - Centre-nord	2 504,7	195 531	97 227	34 133	0	326 891
Brésil - Nord-est	1 248,4	3 009	2 760	183	0	5 952
Total régional (côte nord)	9 363,2	2 088 809	335 096	60 681	12 911	2 497 497
Côte de l'Atlantique						
Brésil - Est	939,0	1 817	679	143	0	2 639
Brésil - Rio	394,9	688	4 885	0	0	5 573
Brésil - Sao Paulo	784,5	11	1	0	0	12
Brésil - Rio Grande do Sul	882,9	24 078	1 762	7	0	25 847
Uruguay	621,9	3 137	6 960	422	0	10 519
Argentine - Buenos Aires	921,8	1 625	1 994	482	103	4 204
Argentine - Fleuve Colorado	910,5	4 967	1 846	318	0	7 131
Argentine - Presqu'île de Valdés	784,9	1 815	5 086	0	1	6 902
Argentine - Golfe de San Jorge	730,9	7 559	9 128	357	90	17 134
Argentine - Fleuve Gallegos	770,9	1 700	550	163	0	2 413
Argentine - Terre de Feu	430,0	23 763	11 591	19 486	0	54 840
Chili - Terre de Feu	619,2	11 210	43 206	11 779	0	66 195
Total régional (côte de l'Atlantique)	8 791,4	82 370	87 688	33 157	194	203 409
Côte du Pacifique						
Chili - Chiloé	1 432,0	19 164	789	18 856	0	38 809
Chili - Concepción	880,7	4 563	51	617	0	5 231
Chili - Valparaíso	543,0	9 166	87	384	0	9 637
Chili - La Serena	846,2	4 395	108	291	0	4 794
Chili - Antofagasta	582,8	1 327	128	33	0	1 488
Chili - Arica	583,6	1 361	63	59	0	1 483
Pérou - Mollendo	683,9	14 854	6 393	81	0	21 328
Pérou - Lima	792,7	19 995	2 335	988	0	23 318
Pérou - Chimbote	426,1	2 171	435	65	0	2 671
Pérou - Chiclayo	871,6	52 655	14 204	1 100	0	67 959
Équateur	1 385,5	2 274	3 485	4 006	0	9 765
Colombie - Côte du Pacifique	746,9	24 718	6 224	999	0	31 941
Total régional (côte du Pacifique)	9 775,0	156 643	34 302	27 479	0	218 424
Total	27 929,6	2 327 822	457 086	121 317	13 105	2 919 330

de la côte nord du continent, principalement les Guyanes et plus particulièrement le Surinam, accueille nettement les plus forts nombres de petits oiseaux de rivage, des Bécasseaux semipalmés surtout. Sur les plus de 2 083 000 petits bécasseaux dénombrés dans cette région, 64,6 % se trouvaient au Surinam, 18,9 %, en Guyane française, et 0,5 %, à la Guyana; les Guyanes comptaient donc environ 84 % du nombre total de petits bécasseaux hivernant sur la côte nord. Le centre-nord de la côte du Brésil, avec 9,2 % du total, et le delta de l'Orénoque au Venezuela, avec 3,3 %, constituaient d'autres zones importantes de la côte nord.

Relativement peu de petits oiseaux de rivage ont été aperçus fréquentant les habitats tropicaux de la partie nord de la côte Atlantique (est), malgré la présence d'estuaires ou de baies offrant des slikkes (estrans vaseux) et des mangroves aux environs de Salvador. On observe un phénomène similaire dans la partie nord de la côte du Pacifique où beaucoup de zones qui semblaient offrir des habitats estuariens convenables, comme le golfe de Guayaquil et la baie de Buenaventura, étaient relativement peu fréquentées par les petits oiseaux de rivage.

D'après des études d'oiseaux bagués (Morrison et Spaans, 1979; Spaans, 1984), des collections de musées (données inédites) et des observations sur le terrain (Spaans, 1978, 1979), la majorité des petits oiseaux de rivage identifiés comme de petits bécasseaux sur la côte nord seraient des Bécasseaux semipalmés, bien que le Bécasseau d'Alaska (aussi appelé Bécasseau du Nord-Ouest), *Calidris mauri*, qui lui est très proche, soit également présent. De grands nombres de ce dernier en migration sont observés sur la côte ouest de l'Amérique du Nord, par exemple dans les deltas de la rivière Copper et du fleuve Fraser (Senner *et al.*, 1981). Cependant, les Bécasseaux de l'Alaska ne constituent qu'une faible proportion des populations hivernant sur la côte nord, et relativement peu de petits bécasseaux séjournant dans la partie nord-ouest de la côte Pacifique de l'Amérique du Sud ont été observés. On pourrait donc croire que les principales aires d'hivernage du Bécasseau d'Alaska se trouvent au

Tableau 3.3a
Nombres totaux par espèces des oiseaux de rivage de la région néarctique recensés dans chaque région et chaque unité écologique de la côte de l'Amérique du Sud — Petits oiseaux de rivage

Région/Unité écologique	Étendue de l'unité écologique (km)	Pluvier semipalmé	Chevalier branlequeue	Chevalier solitaire	Bécasseau à poitrine cendrée	Bécasseau à croupion blanc	Bécasseau sanderling	Petits oiseaux de rivage non identifiés	Total (Petits oiseaux de rivage)
Côte nord									
Colombie - Côte caraïbe	853,7	0	28	0	0	0	56	4 871	4 955
Venezuela - Côte caraïbe occidentale	1 113,2	0	10	0	0	0	194	9 436	9 640
Venezuela - Côte caraïbe centrale	275,6	0	1	0	0	0	0	15 202	15 203
Venezuela - Orénoque	549,2	0	7	0	0	0	460	69 166	69 633
Trinité	483,8	0	21	0	0	0	5	12 367	12 393
Guyana	478,5	0	23	0	0	0	30	9 755	9 808
Surinam	369,8	0	10	0	0	0	42	1 346 573	1 346 625
Guyane française	388,2	0	5	0	0	0	2	394 327	394 334
Brésil - Nord	464,3	0	2	0	0	0	2	25 594	25 598
Brésil - Amazone	633,8	470	4	0	0	0	117	1 489	2 080
Brésil - Centre-nord	2 504,7	0	246	1	0	0	3 080	192 204	195 531
Brésil - Nord-est	1 248,4	0	3	0	0	0	380	2 626	3 009
Total régional (côte nord)	9 363,2	470	360	1	0	0	4 368	2 083 610	2 088 809
Côte de l'Atlantique									
Brésil - Est	939,0	0	20	1	65	0	261	1 470	1 817
Brésil - Rio	394,9	0	2	0	0	0	524	162	688
Brésil - Sao Paulo	784,5	0	0	0	0	0	0	11	11
Brésil - Rio Grande do Sul	882,9	0	0	0	1	2 340	6 618	15 119	24 078
Uruguay	621,9	0	3	0	0	1	5	3 128	3 137
Argentine - Buenos Aires	921,8	0	0	0	0	0	253	1 372	1 625
Argentine - Fleuve Colorado	910,5	0	0	0	0	0	240	4 727	4 967
Argentine - Presqu'île de Valdés	784,9	0	0	0	0	0	777	1038	1 815
Argentine - Golfe de San Jorge	730,9	0	0	0	0	0	75	7 484	7 559
Argentine - Fleuve Gallegos	770,9	0	0	0	0	0	0	1 700	1 700
Argentine - Terre de Feu	430,0	0	0	0	0	0	504	23 259	23 763
Chili - Terre de Feu	619,2	0	0	0	0	0	25	11 185	11 210
Total régional (côte de l'Atlantique)	8 791,4	0	25	1	66	2 341	9 282	70 655	82 370
Côte du Pacifique									
Chili - Chiloé	1 432,0	0	0	0	0	0	10 194	8 970	19 164
Chili - Concepción	880,7	0	0	0	0	0	4 543	20	4 563
Chili - Valparaíso	543,0	0	0	0	0	0	8 442	724	9 166
Chili - La Serena	846,2	0	0	0	0	0	4 395	0	4 395
Chili - Antofagasta	582,8	0	0	0	0	0	1 327	0	1 327
Chili - Arica	583,6	0	0	0	0	0	1 361	0	1 361
Pérou - Mollendo	683,9	0	1	0	0	0	14 242	611	14 854
Pérou - Lima	792,7	0	1	0	0	0	18 831	1 163	19 995
Pérou - Chimbote	426,1	0	8	0	0	0	2 163	0	2 171
Pérou - Chiclayo	871,6	0	23	0	0	0	31 610	21 022	52 655
Équateur	1 385,5	0	5	0	0	0	230	2 039	2 274
Colombie -Côte du Pacifique	746,9	0	8	0	0	0	827	23 883	24 718
Total régional (côte du Pacifique)	9 775,0	0	46	0	0	0	98 165	58 432	156 643
Total	27 929,6	470	431	2	66	2 341	111 815	2 212 697	2 327 822

nord du continent sud-américain. D'ailleurs, des populations importantes ont été observées récemment au Panama (R.I.G. Morrison, R.K. Ross et F. Delgado, données inédites; B.A. Harrington et J.P. Myers, comm. pers.).

Il existe un cline de taille chez les Bécasseaux semipalmés sur l'ensemble de leur territoire de reproduction, les plus gros oiseaux fréquentant l'est de l'Arctique, et les plus petits, l'Alaska (Harrington et Morrison, 1979). Ce cline est apparent jusqu'à un certain point dans les observations faites sur la côte nord de l'Amérique du Sud. Les plus gros oiseaux qui hivernent sur la côte nord du Brésil proviennent probablement des aires de nidification situées dans l'est de l'Arctique, tandis que les plus petits qui se trouvent sur les parties ouest de la côte nord et la partie nord de la côte du Pacifique seraient originaires des aires de nidification situées à l'ouest (Morrison, 1983, 1984).

Dans la partie sud de la région de la côte Atlantique, des concentrations modérées de petits oiseaux de rivage ont été observées, plus particulièrement dans l'État du Rio Grande do Sul du Brésil méridional et en Terre de Feu (Argentine et Chili). D'après les études d'oiseaux bagués et les observations faites dans cette partie de la côte, peu de Bécasseaux semipalmés iraient si loin au sud, et la majorité des oiseaux s'y trouvant seraient des Bécasseaux à croupion blanc. Les plus importantes aires d'hivernage relevées dans cette zone sont la côte Atlantique de la Terre de Feu en Argentine, où se trouvaient 31,9 % des quelque 73 000 petits bécasseaux recensés dans la région, et les secteurs chiliens de la Terre de Feu, surtout les zones bordant le détroit de Magellan, avec 15,3 % du total régional. Une autre zone particulièrement importante est celle des lagunes de l'État du Rio Grande do Sul dans le sud du Brésil, plus particulièrement la Lagoa do Peixe. À l'exté-

Tableau 3.3*b*
Nombres totaux par espèces des oiseaux de rivage de la région néarctique recensés dans chaque région et chaque unité écologique de la côte de l'Amérique du Sud — Oiseaux de rivage de taille moyenne

Région/Unité écologique	Étendue de l'unité écologique (km)	Pluvier doré d'Amérique	Pluvier argenté	Tournepierre à collier	Bécasseau du ressac	Grand et Petit chevaliers	Bécasseau maubèche	*Limnodromus* spp.	Oiseaux de rivage moyens non identifiés	Total (Oiseaux de rivage moyens)
Côte nord										
Colombie - Côte caraïbe	853,7	0	1 241	175	0	19	0	1 558	3 020	6 014
Venezuela - Côte caraïbe occidentale	1 113,2	0	212	219	0	1 290	520	0	7 964	10 205
Venezuela - Côte caraïbe centrale	275,6	0	48	0	0	779	0	7 113	300	8 240
Venezuela - Orénoque	549,2	0	143	42	0	308	0	3 100	10 435	14 028
Trinité	483,8	0	173	6	0	518	0	209	80	986
Guyana	478,5	0	598	48	0	6 824	0	2 900	1 248	11 618
Surinam	369,8	0	3 940	619	0	66 377	0	21 840	55 392	148 168
Guyane française	388,2	0	640	601	0	5 117	0	2 400	24 148	32 906
Brésil - Nord	464,3	47	676	191	0	205	120	20	1 064	2 323
Brésil - Amazone	633,8	0	101	4	0	227	0	150	139	621
Brésil - Centre-nord	2 504,7	0	14 711	17 909	0	798	8 191	8 105	47 508	97 227
Brésil - Nord-est	1 248,4	82	1 289	433	0	218	15	35	688	2 760
Total régional (côte nord)	9 363,2	129	23 772	20 247	0	82 686	8 846	47 430	151 986	335 096
Côte de l'Atlantique										
Brésil - Est	939,0	0	168	321	0	59	0	0	131	679
Brésil - Rio	394,9	0	76	1	0	4 808	0	0	0	4 885
Brésil - Sao Paulo	784,5	0	0	0	0	0	0	0	1	1
Brésil - Rio Grande do Sul	882,9	629	3	0	0	419	0	0	711	1 762
Uruguay	621,9	3 167	365	253	0	88	0	0	3 087	6 960
Argentine - Buenos Aires	921,8	85	0	0	0	642	0	0	1 267	1 994
Argentine - Fleuve Colorado	910,5	30	5	0	0	1	50	0	1 760	1 846
Argentine - Presqu'île de Valdés	784,9	0	5	0	0	55	5 023	0	3	5 086
Argentine - Golfe de San Jorge	730,9	0	0	320	0	17	8 691	0	100	9 128
Argentine - Fleuve Gallegos	770,9	0	0	0	0	0	550	0	0	550
Argentine - Terre de Feu	430,0	0	0	1	0	0	10 470	0	1 120	11 591
Chili - Terre de Feu	619,2	0	0	2	0	14	42 762	0	428	43 206
Total régional (côte de l'Atlantique)	8 791,4	3 911	622	898	0	6 103	67 546	0	8 608	87 688
Côte du Pacifique										
Chili - Chiloé	1 432,0	0	0	0	20	164	0	0	605	789
Chili - Concepción	880,7	0	0	0	0	36	0	0	15	51
Chili - Valparaíso	543,0	0	2	0	20	10	0	0	55	87
Chili - La Serena	846,2	14	4	29	61	0	0	0	0	108
Chili - Antofagasta	582,8	0	0	113	15	0	0	0	0	128
Chili - Arica	583,6	1	22	6	4	0	0	0	30	63
Pérou - Mollendo	683,9	0	587	156	45	918	0	0	4 644	6 393
Pérou - Lima	792,7	0	440	582	0	497	0	0	756	2 335
Pérou - Chimbote	426,1	0	114	259	30	30	0	0	2	435
Pérou - Chiclayo	871,6	0	203	911	2	454	0	0	12 633	14 204
Équateur	1 385,5	0	1 082	109	0	135	0	825	1 334	3 485
Colombie - Côte du Pacifique	746,9	0	419	189	0	20	0	604	4 992	6 224
Total régional (côte du Pacifique)	9 775,0	15	2 873	2 354	197	2 368	0	1 429	25 066	34 302
Total	27 929,6	4 055	27 267	23 499	197	91 047	76 392	48 859	185 660	457 086

rieur de la Terre de Feu, c'est la zone la plus importante, comptant pour 20,7 % du total régional. Quant aux lagunes côtières de l'Uruguay, elles abritaient 4,3 % de l'effectif régional. Des populations plus faibles ont été observées en Argentine, les portions les plus fréquentées de la côte se trouvant autour du golfe de San Jorge.

La plupart des oiseaux recensés se trouvaient sur les bancs rocheux (*restingas*) de la côte argentine, sur des estrans rocheux ou vaseux ou dans des lagunes. Peu d'habitats à l'intérieur des terres ont été couverts par les recensements dans les zones côtières de la province de Buenos Aires, mais il est connu que des nombres importants de Bécasseaux à croupion blanc et de Bécasseaux de Baird, *Calidris bairdii*, y hivernent (Myers et Myers, 1979).

3.2.2. Bécasseau sanderling, *Calidris alba*

Près de 112 000 Bécasseaux sanderlings ont été observés lors des recensements. Les plus importants lieux d'hivernage étaient clairement les longues plages océaniques de la côte du Pacifique (carte 3.2), où se trouvaient 87,8 % d'entre eux, les côtes de l'Atlantique et du nord n'en accueillant que 8,3 et 3,9 %, respectivement. Les Bécasseaux sanderlings étaient d'ailleurs les plus nombreux des petits oiseaux de rivage fréquentant les plages de la côte du Pacifique, représentant 94 à 100 % des oiseaux de cette catégorie dans les unités écologiques situées entre Chiloé, dans le sud du Chili, et la côte nord du Pérou.

Ensemble, le Pérou (68,1 %) et le Chili (30,8 %) abritaient 98,9 % des sanderlings hivernant sur la côte du Pacifique. Les plus importantes aires d'hivernage se trouvaient dans le nord du Pérou, spécialement dans la région de Chiclayo, où près de 32 000 individus ont été comptés (32,2 % du total régional pour la côte du Pacifique). La partie de la côte située près de Pacasmayo, où plus de 11 000 individus ont été observés, et la vaste plage océanique à l'avant du désert de Sechura représentaient des

Tableau 3.3c
Nombres totaux par espèces des oiseaux de rivage de la région néarctique recensés dans chaque région et chaque unité écologique de la côte de l'Amérique du Sud — Gros oiseaux de rivage

Région/Unité écologique	Étendue de l'unité écologique (km)	Courlis corlieu	Chevalier semipalmé	Barge hudsonienne	Gros oiseaux de rivage non identifiés	Total (Gros oiseaux de rivage)
Côte nord						
Colombie - Côte caraïbe	853,7	29	21	0	0	50
Venezuela - Côte caraïbe occidentale	1 113,2	114	121	0	171	406
Venezuela - Côte caraïbe centrale	275,6	5	464	0	50	519
Venezuela - Orénoque	549,2	207	273	0	0	480
Trinité	483,8	75	184	0	0	259
Guyana	478,5	57	283	0	0	340
Surinam	369,8	3 310	15 646	0	2 580	21 536
Guyane française	388,2	326	729	0	1 039	2 094
Brésil - Nord	464,3	138	25	0	511	674
Brésil - Amazone	633,8	0	0	0	2	7
Brésil - Centre-nord	2 504,7	10 879	21 868	4	1 382	34 133
Brésil - Nord-est	1 248,3	117	26	0	40	183
Total régional (côte nord)	9 363,2	15 257	39 640	4	5 775	60 681
Côte de l'Atlantique						
Brésil - Est	939,0	66	77	0	0	143
Brésil - Rio	394,9	0	0	0	0	0
Brésil - Sao Paulo	784,5	0	0	0	0	0
Brésil - Rio Grande do Sul	882,9	3	0	0	4	7
Uruguay	621,9	2	0	326	94	422
Argentine - Buenos Aires	921,8	6	0	429	47	482
Argentine - Fleuve Colorado	910,5	0	0	313	5	318
Argentine - Presqu'île de Valdés	784,9	0	0	0	0	0
Argentine - Golfe de San Jorge	730,9	0	0	352	5	357
Argentine - Fleuve Gallegos	770,9	0	0	160	3	163
Argentine - Terre de Feu	430,0	14	0	19 472	0	19 486
Chili - Terre de Feu	619,2	119	0	11 660	0	11 779
Total régional (côte de l'Atlantique)	8 791,4	210	77	32 712	158	33 157
Côte du Pacifique						
Chili - Chiloé	1 432,0	6 210	0	12 642	4	18 856
Chili - Concepción	880,7	617	0	0	0	617
Chili - Valparaíso	543,0	384	0	0	0	384
Chili - La Serena	846,2	291	0	0	0	291
Chili - Antofagasta	582,8	31	2	0	0	33
Chili - Arica	583,6	59	0	0	0	59
Pérou - Mollendo	683,9	79	1	1	0	81
Pérou - Lima	792,7	620	156	170	42	988
Pérou - Chimbote	426,1	65	0	0	0	65
Pérou - Chiclayo	871,6	169	431	0	500	1 100
Équateur	1 385,5	562	3 384	0	60	4 006
Colombie - Côte du Pacifique	746,9	320	679	0	0	999
Total régional (côte du Pacifique)	9 775,0	9 407	4 653	12 813	606	27 479
Total	27 929,6	24 874	44 370	45 529	6 539	121 317

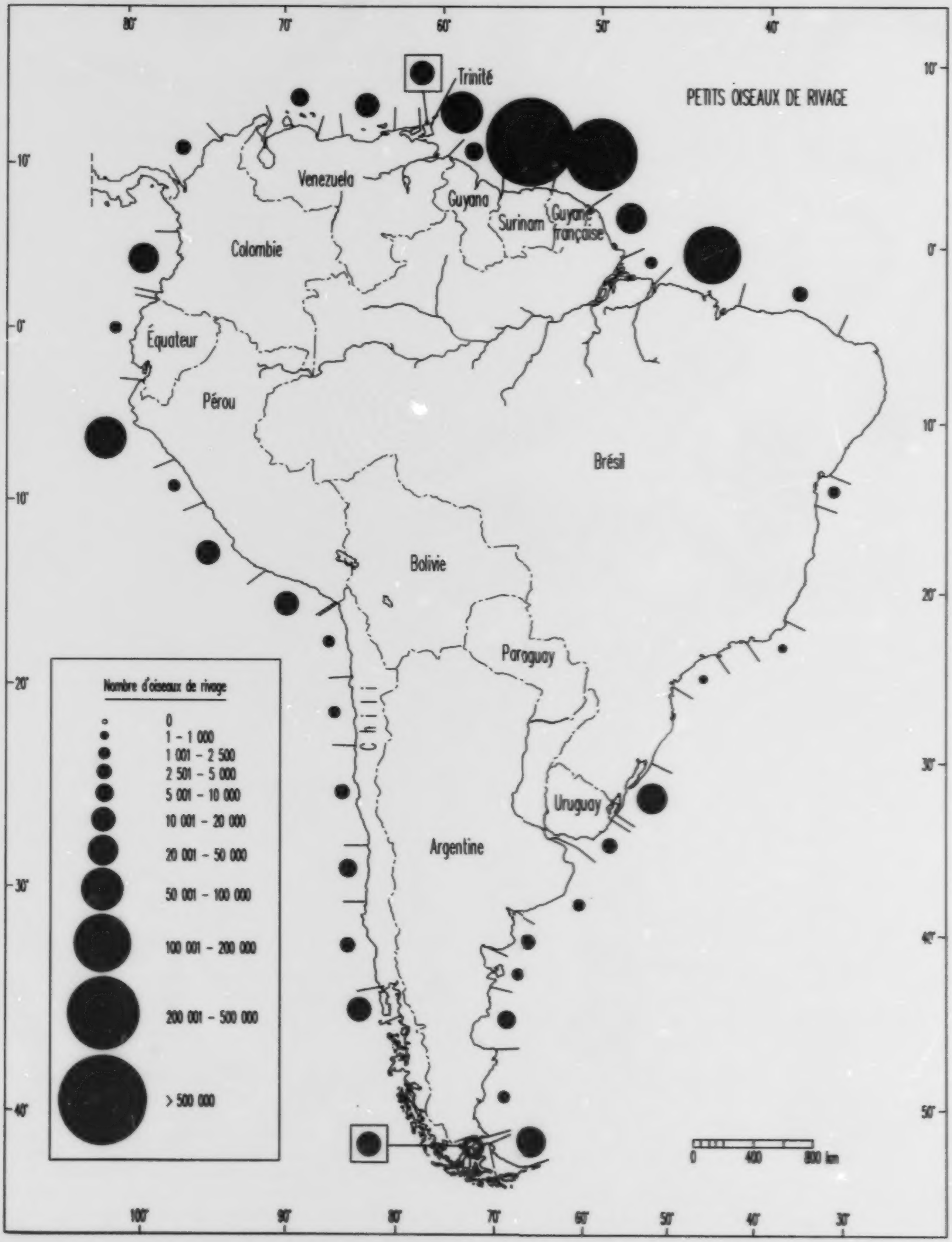
zones particulièrement importantes. Les plages du centre et du sud du Pérou étaient également fort fréquentées, avec 19,1 et 14,5 %, respectivement du total, pour la région. Des concentrations modérées à élevées ont été notées sur les plages du centre et du sud du Chili, notamment dans la zone de Chiloé (10,4 % du total régional) où plus de 2 500 individus ont été aperçus près de Coulin sur la côte nord de l'île de Chiloé.

Dans la partie sud de la région de la côte Atlantique, les Bécasseaux sanderlings étaient en nombres modérés à faibles. 70,5 % des 9 300 représentants de cette espèce comptés dans la région se trouvaient sur les plages océaniques de l'État du Rio Grande do Sul, au Brésil; les plages accolées à des lagunes côtières, notamment à la Lagoa do Peixe, étaient les plus utilisées.

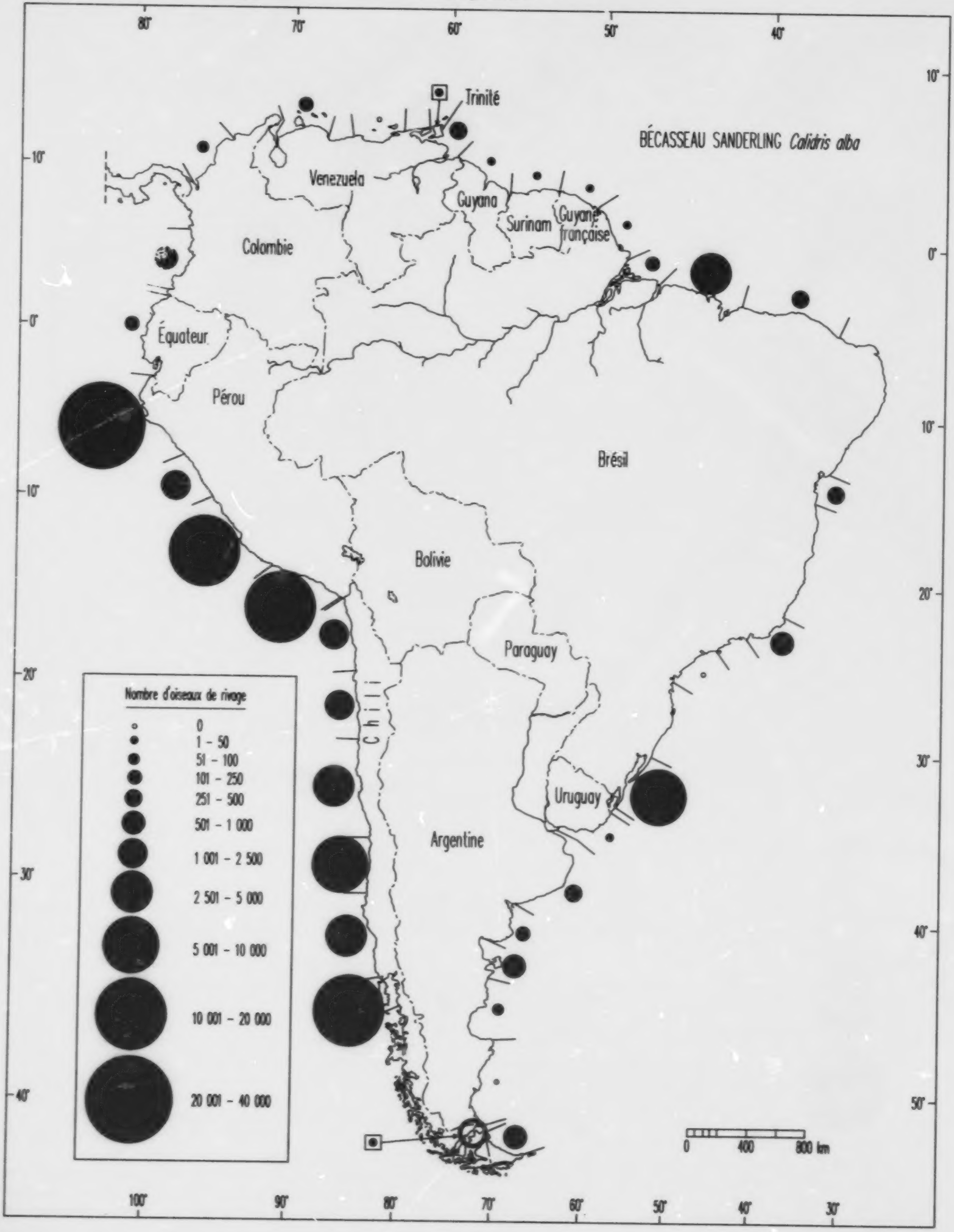
Sur la côte nord de l'Amérique du Sud, les nombres étaient encore plus faibles, le total régional de 4 400 individus ne représentant que 3,9 % du total pour toute l'Amérique du Sud. La majorité des sanderlings recensés dans la région (71,3 %) se trouvaient sur les caps extérieurs sableux de la partie du centre-nord, fortement échancrée, de la côte brésilienne, surtout près de São Luis.

Les densités ainsi que les nombres observés étaient plus élevés sur la côte du Pacifique que sur celle de l'Atlantique. (Voir également Morrison, 1984; Myers *et al.*, 1985.) La plus forte densité enregistrée est de 1 095 individus par kilomètre dans un secteur de recensement peu étendu (7,03 km) situé à l'embouchure de la rivière Pisco, au Pérou, où se trouvaient des groupes nombreux d'individus au repos (7 700 oiseaux). Ailleurs, les densités les plus élevées ont été observées dans le nord du Pérou, sur la côte et à proximité du désert de Sechura. Les densités atteignaient 278 individus par kilomètre aux environs de Pacasmayo et 186 par kilomètre près de l'extrémité nord-ouest de la plage du désert de Sechura; la densité moyenne pour l'ensemble de cette zone était de 117 individus par kilomètre. Les densités étaient également élevées dans le sud du Pérou, à proximité de la frontière du Chili, atteignant

Carte 3.1
Distribution des petits oiseaux de rivage sur les côtes de l'Amérique du Sud


PETITS OISEAUX DE RIVAGE
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 50 000
50 001 - 100 000
100 001 - 200 000
200 001 - 500 000
> 500 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Carte 3.2
Distribution des Bécasseaux sanderlings, *Calidris alba*, sur les côtes de l'Amérique du Sud


BÉCASSEAU SANDERLING *Calidris alba*
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°
50°
10°
0°
10°
20°
30°
40°

242 individus par kilomètre près de Tacna. Ailleurs au Pérou et au Chili, de 25 à 60 individus par kilomètre représentaient généralement une densité élevée. Sur la côte de l'Atlantique, on a enregistré la plus forte densité dans l'État du Rio Grande do Sul, dans le Brésil méridional, près de la Lagoa do Peixe (69 individus par kilomètre); sur la côte nord, la densité maximale observée a été de 25 individus par kilomètre près de São Luis.

Des observations d'oiseaux marqués (Myers *et al.*, 1984) ont indiqué que beaucoup de Bécasseaux sanderlings hivernant sur la côte du Pacifique se rendaient à leurs lieux de reproduction dans le nord en suivant la côte ouest de l'Amérique du Nord ou en traversant le continent centralement, passant par la côte texane du golfe du Mexique et par les Prairies, et que pour revenir à leur territoire d'hivernage ils suivaient la côte est de l'Amérique du Nord ou passaient par l'intérieur. Beaucoup d'oiseaux suivraient donc un circuit migratoire elliptique dans le sens des aiguilles d'une montre. En ce qui concerne les individus qui migrent vers le nord en suivant la côte Atlantique des États-Unis au printemps où se trouvent d'importantes haltes, comme la baie de la Delaware, on pense que la majorité d'entre eux ne proviennent pas des lieux d'hivernage situés en Amérique du Sud du côté du Pacifique mais qu'il s'agirait plutôt de la population qui hiverne du côté de l'Atlantique.

3.2.3. Oiseaux de rivage de taille moyenne

Quelque 457 000 oiseaux de cette catégorie ont été aperçus lors des recensements (tableau 3.2). Plusieurs lieux de concentration ont été observés, et les espèces prédominantes variaient d'une région à l'autre (carte 3.3, tableau 3.3*b*). La côte nord du continent était particulièrement importante, surtout pour le Pluvier argenté *Pluvialis squatarola*, le Tournepierre à collier (aussi appelé Tournepierre roux), *Arenaria interpres*, le Grand et le Petit Chevaliers, *Tringa* spp., et les bécasseaux, *Limnodromus* spp. À elles seules, les Guyanes abritaient 42,1 % du nombre total d'oiseaux de rivage de taille moyenne recensés en Amérique du Sud (Surinam : 32,4 %; Guyane française : 7,2 %; Guyana : 2,5 %). Le centre-nord du Brésil en accueillait également des nombres très importants, soit 21,3 % du total. Les grosses populations de ces oiseaux hivernant en Argentine et au Chili (6,6 et 9,7 % du total, respectivement) étaient surtout constituées de Bécasseaux maubèches (aussi appelés Bécasseaux à poitrine rousse), *Calidris canutus*, sur les côtes de la Terre de Feu et de la Patagonie. Relativement peu d'oiseaux de cette catégorie se trouvaient sur la côte du Pacifique au Chili et au Pérou; sur les plages, le Tournepierre à collier et le Pluvier argenté figuraient parmi les espèces les plus communes de cette catégorie, les Grand et Petit Chevaliers, le Pluvier argenté et diverses autres espèces fréquentant les marais côtiers. En Équateur et en Colombie, des nombres modérés ont été observés sur les slikkes (estrans vaseux) de la côte du Pacifique.

3.2.4. Pluvier argenté, *Pluvialis squatarola*

Les principales aires d'hivernage du Pluvier argenté sont situées sur les côtes tropicales de la moitié nord de l'Amérique du Sud, plus particulièrement sur la côte nord (carte 3.4). En effet, des 27 300 Pluviers argentés recensés, 87,2 % se trouvaient dans cette région, 10,5 %, sur la côte du Pacifique, et 2,3 %, sur la côte de l'Atlantique.

Le centre-nord de la côte du Brésil entre Belém et São Luis représentait la plus importante zone d'hivernage, abritant 14 700 individus, soit environ 61,9 % du nombre total pour la côte nord ou 54,0 % du total pour l'Amérique du Sud. Il s'agit d'une portion très échancrée de la côte, formée de baies et de caps qui offrent de grandes étendues d'estrans vaseux et sableux, de mangroves et de plages où le Pluvier argenté trouve de nombreux habitats pour l'alimentation et le repos. Plus de 2 500 km de la très longue bande littorale ont été couverts. La densité globale pour l'unité écologique était de six individus par kilomètre, mais les chiffres pour des secteurs particuliers pouvaient atteindre 26 individus par kilomètre. Le Surinam était la deuxième zone en importance, comptant pour 16,6 % du total régional (14,5 % du total pour l'Amérique du Sud). La côte y est beaucoup plus droite et consiste en des slikkes très étendues alternant avec des plages et des bancs de boues durcies. La densité y était de 10,7 individus par kilomètre en moyenne pour l'unité écologique; elle pouvait atteindre 49 individus par kilomètre dans certains secteurs, mais le plus souvent elle ne dépassait pas 20 individus par kilomètre.

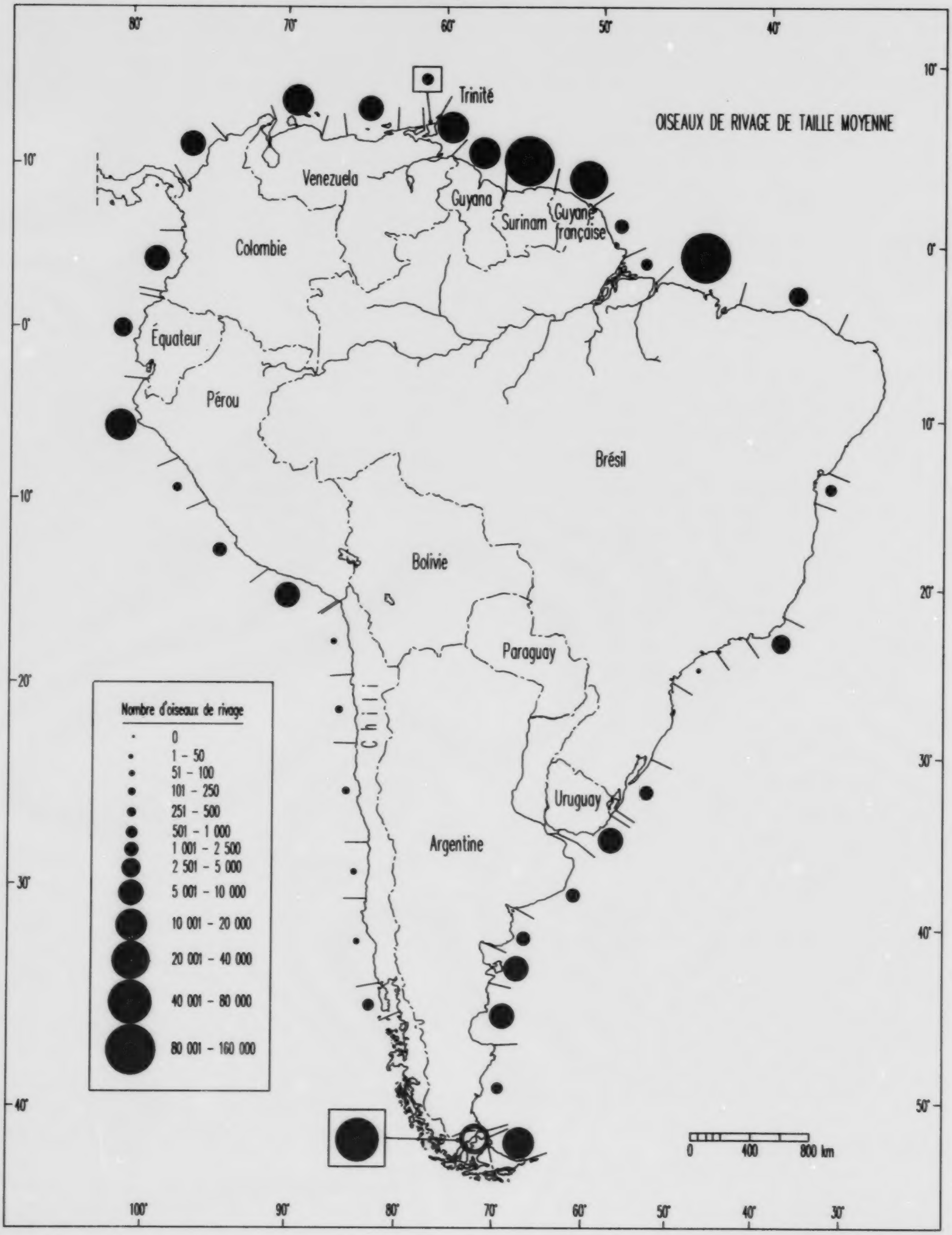
La côte caraïbe de la Colombie (1 200 individus; 5,2 % du total pour la côte nord et 4,6 % du total pour l'Amérique du Sud) et la côte nord-est du Brésil (1 300 individus; 5,4 et 4,7 % des mêmes totaux respectivement) représentent d'autres zones importantes pour le Pluvier argenté. En Colombie, la majorité des oiseaux de cette espèce ont été observés dans des zones de lagunes peu profondes accolées au rivage, surtout près de l'embouchure du fleuve Magdalena à proximité de Barranquilla. Dans le nord-est du Brésil, les oiseaux se trouvaient généralement sur des plages océaniques à formations de grès, plus particulièrement entre São Luis et Parnaiba.

Du côté du Pacifique, le Pluvier argenté a été aperçu principalement au Pérou, en Équateur et en Colombie; seulement quelques individus dispersés ont été vus au Chili au sud de la zone de la frontière péruvienne. Les individus (2) les plus au sud se trouvaient près de la rivière Mataquito dans l'unité écologique de Valparaiso. Au Pérou, où l'on n'a relevé que 1 300 individus (représentant 46,8 % du total pour la côte du Pacifique et 4,9 % du total pour l'Amérique du Sud), beaucoup d'observations ont été faites sur les zones humides côtières qui sont très éloignées les unes des autres. Dans la partie sud du pays, le Pluvier a été observé sur des zones humides côtières près des embouchures des rivières Camana (235) et Locumba (120) et aux lagunes de Mejia (110). Presque tous les autres endroits fréquentés par le Pluvier argenté dans le centre et le nord du Pérou consistaient en des zones humides côtières ou des plages bordant de telles zones humides (ex. : rivière de Huaura, Paramonga, baie de Sechura). L'un des plus gros groupes aperçus, comptant 260 individus, se trouvait dans la baie de Paracas, à l'intérieur de la réserve nationale.

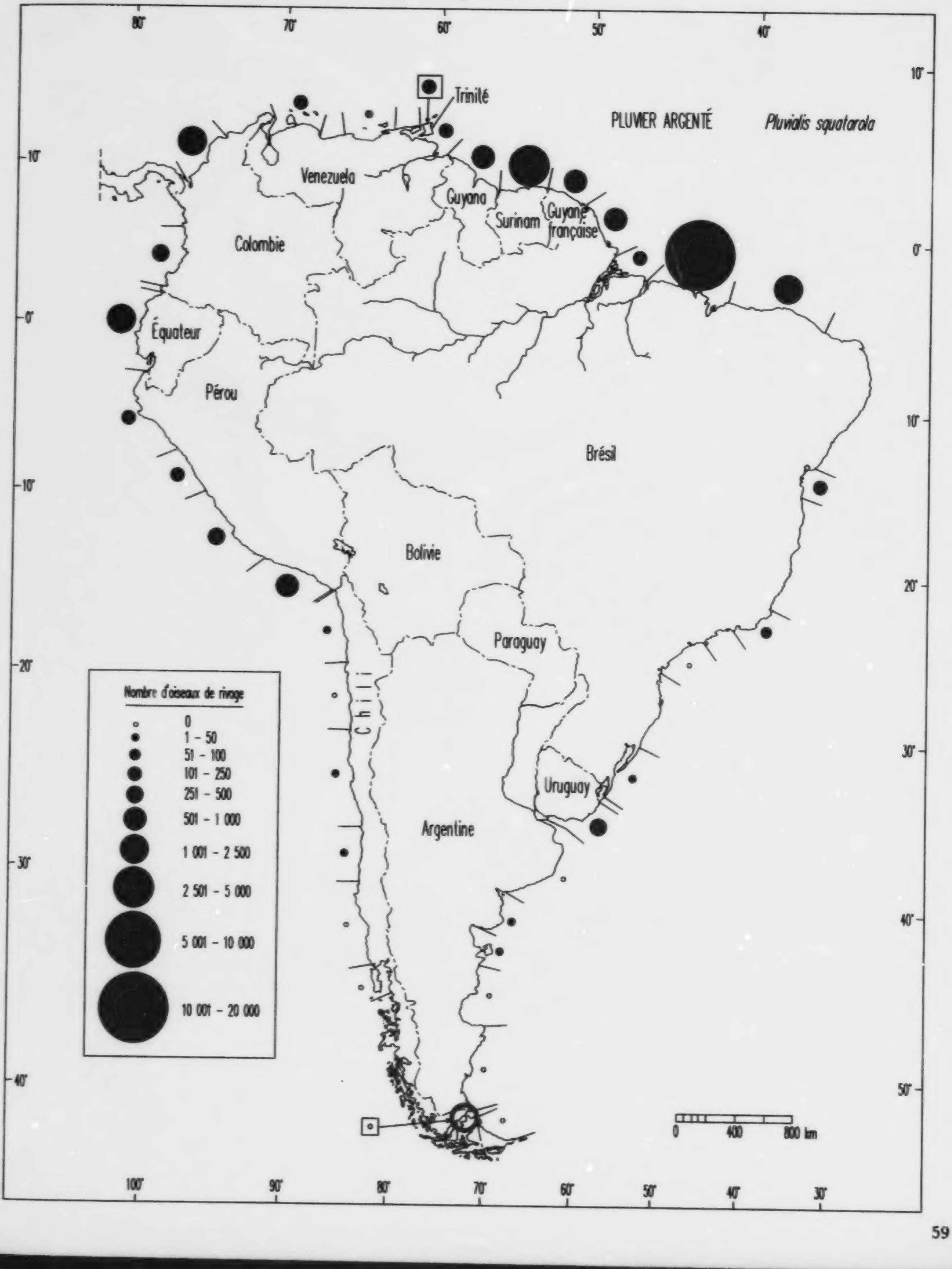
En Équateur, le Pluvier argenté fréquentait principalement les côtes du golfe de Guayaquil. La plupart des individus ont été observés autour des côtes extérieures du golfe, où ils trouvent estrans et habitats sableux, plutôt que dans les parties plus intérieures et vaseuses, bordées par la mangrove. Des habitats appréciés se trouvaient au nord de la frontière avec le Pérou, dans le coin sud-est de l'île Puna et à l'entrée de la baie du côté nord-ouest. L'espèce était des plus communes dans les habitats similaires existant dans le sud de la Colombie entre Tumaco et Buenaventura.

Peu de Pluviers argentés ont été observés sur la côte de l'Atlantique (620 ou 2,3 % du total pour l'Amérique du Sud). D'ailleurs, on n'en a aperçu qu'un nombre très

Carte 3.3
Distribution des oiseaux de rivage de taille moyenne sur les côtes de l'Amérique du Sud


OISEAUX DE RIVAGE DE TAILLE MOYENNE
Trinité
Venezuela
Colombie
Guyana
Surinam
Guyane française
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
80 001 - 160 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Carte 3.4
Distribution des Pluviers argentés, *Pluvialis squatarola*, sur les côtes de l'Amérique du Sud


PLUVIER ARGENTÉ
Pluvialis squatarola
Trinité
Venezuela
Colombie
Guyana
Surinam
Guyane française
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Argentine
Uruguay
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

faible au sud de l'Uruguay, en Argentine : quelques-uns dans l'estuaire près de Bahia Blanca et sur la côte près de l'estuaire de San Antonio Oeste. La plus forte concentration se trouvait à la Laguna de Rocha qui est une vaste lagune d'eau saumâtre adjacente à la côte de l'Uruguay. De petits nombres ont été aperçus sur les plages au nord de Rio de Janeiro où il existe de petits étangs et de petites lagunes à l'arrière du rivage, ainsi que dans la baie de Todos os Santos près de Salvador. Des nombres encore plus faibles ont été observés dans les estuaires plus boueux, bordés par la mangrove, au sud de Salvador près de Valença et d'Itubera.

3.2.5. Tournepierre à collier, *Arenaria interpres*

Les Tournepierres à collier sont largement répandus en Amérique du Sud où on les observe en petits nombres jusqu'à la Terre de Feu au sud. Surtout nombreux sur la côte nord du continent, ils sont aussi assez communs sur les plages de la côte du Pacifique (carte 3.5). Des 23 500 individus dénombrés lors des recensements, 86,2 % se trouvaient sur la côte nord, 10,0 %, sur la côte Pacifique, et seulement 3,8 %, sur la côte Atlantique.

La zone de loin la plus importante pour les Tournepierres à collier est le centre-nord de la côte du Brésil entre Belém et São Luis, où l'on en a compté plus de 17 900, soit 76,2 % du total pour l'Amérique du Sud (88,5 % du total pour la côte nord). Cette longue étendue échancrée de la côte renferme de nombreux bancs de boues durcies, habitats très appréciés par les tournepierres. D'autres zones importantes se trouvent au Surinam (2,6 et 3,1 % des totaux pour l'Amérique du Sud et la côte nord, respectivement) et en Guyane française (2,6 et 3,0 % des mêmes totaux respectivement), ainsi que sur la côte nord-est du Brésil (1,8 et 2,1 % respectivement). Dans les Guyanes, les bancs de boues durcies et les plages constituaient les habitats préférés tandis que dans le nord-est du Brésil, c'étaient les plages océaniques où se trouvaient des formations de grès.

Dans la région de la côte du Pacifique, la majorité des 2 400 individus recensés se trouvaient au Pérou (81,1 % du total régional ou 8,1 % du total pour l'Amérique du Sud). Les tournepierres étaient surtout nombreux dans les secteurs où il y avait à la fois des plages de sable ou de gravier et soit des entrées de rivière, des mares, des zones humides ou des terres agricoles accolées au rivage. En Équateur et en Colombie, l'espèce a ordinairement été observée sur des rivages à plages sablonneuses près d'échancrures de la côte ou de zones offrant de larges étendues intertidales.

Les densités étaient aussi généralement les plus élevées dans la partie du centre-nord de la côte brésilienne, où, dans un certain nombre de secteurs, on a relevé de 10 à 20 individus par kilomètre sur des distances de 60 à 124 km; la densité maximale enregistrée est de 31 individus par kilomètre. Dans les Guyanes, représentant la deuxième zone en importance, les densités étaient généralement plus faibles, ne dépassant pas souvent 1 individu par kilomètre; les plus fortes densités qui ont été enregistrées sont de 9 et de 13 individus par kilomètre et ce, au Surinam et en Guyane française respectivement. Les densités étaient également faibles sur la côte du Pacifique : au Pérou, elles dépassaient rarement 1 individu par kilomètre, la plus forte densité qui y a été enregistrée étant de 12 individus par kilomètre sur les plages situées près du désert de Sechura dans le nord du pays.

3.2.6. Grand et Petit Chevaliers, *Tringa* spp.

Le Grand Chevalier (*T. melanoleuca*) et le Petit Chevalier (*T. flavipes*) sont largement répandus en Amérique du Sud (carte 3.6), mais ils sont particulièrement concentrés sur la côte nord du continent où leurs principales aires d'hivernage se trouvent dans les Guyanes. À cause du risque élevé d'erreurs dans l'identification des deux espèces, du haut des airs, les totaux pour les deux ont été combinés. Au total, plus de 91 000 individus des deux espèces ont été observés au cours des recensements : 90,7 % d'entre eux se trouvaient sur la côte nord, 6,7 %, sur la côte de l'Atlantique, et 2,6 %, du côté du Pacifique.

Les principaux emplacements côtiers d'hivernage de ces oiseaux se trouvent clairement dans les Guyanes. On a recensé dans les trois pays guyanais 78 000 Grands ou Petits Chevaliers, soit 85,9 % du total pour l'Amérique du Sud. Le Surinam est le plus important des trois, abritant 72,8 % de l'effectif total recensé en Amérique du Sud, alors que la Guyana en accueillait 7,5 %, et la Guyane française, 5,6 %. Les chevaliers affectionnaient particulièrement les zones renfermant de grandes étendues d'estrans vaseux et les lagunes adjacentes ouvertes, habitats très abondants dans les Guyanes, surtout au Surinam. Les habitats similaires de l'est de la Guyana et de l'ouest de la Guyane française étaient fortement utilisés. Ailleurs sur la côte nord, les deux espèces fréquentaient principalement les habitats se caractérisant par la présence de lagunes près du rivage, comme les lagunes de Campuchano dans l'ouest du Venezuela, la lagune de Piritu et les lagunes à l'ouest de Barcelona dans le centre du Venezuela et le marais Caroni à la Trinité.

Sur la côte Atlantique, les nombres les plus élevés ont été enregistrés à des endroits humides et peu profonds derrière la côte entre le cap Sao Tomé et Atafona à l'est de la lagune Feia dans l'unité écologique de Rio au Brésil. Les rivages des lagunes non éloignées de la côte étaient également utilisés dans le sud du Brésil, y compris la Lagoa dos Patos, ainsi que des lagunes plus petites proches, en Uruguay (Rocha) et sur la côte de la province de Buenos Aires en Argentine (Mar Chiquita et Salada). Toutefois, en Argentine, les principales concentrations se trouvaient dans les marais côtiers de la baie Samborombon.

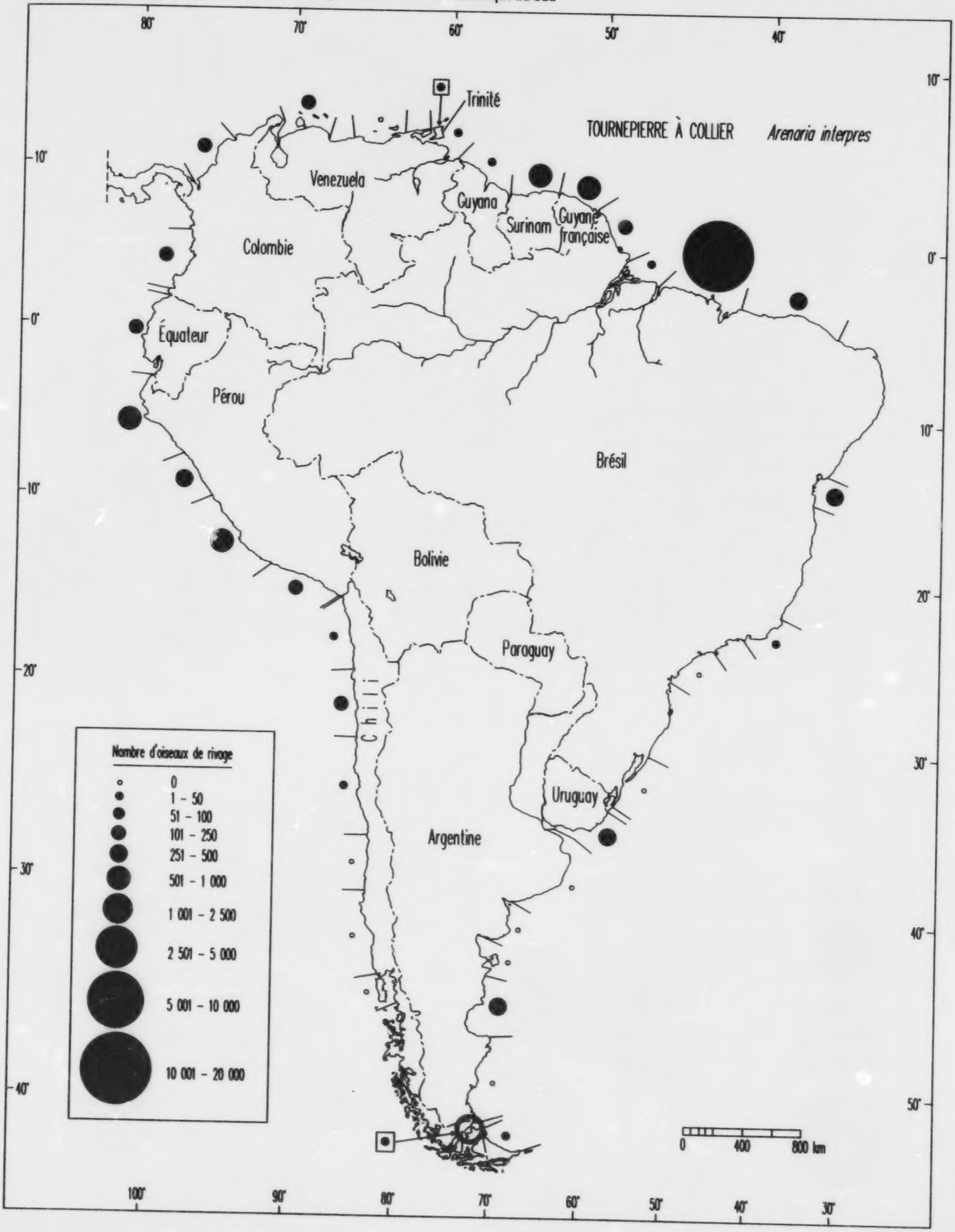
Du côté du Pacifique, les lagunes et marais côtiers ainsi que les zones humides se trouvant à l'embouchure de rivières représentaient encore les habitats les plus importants. Au Pérou, par exemple, les comptes les plus élevés ont été obtenus dans les zones humides de la rivière Camana (900), aux lagunes situées au nord d'Eten (450) et à l'embouchure de la rivière Pisco ainsi que sur les zones humides avoisinantes (340). Des nombres relativement élevés ont également été notés sur les estrans vaseux de la réserve de Paracas.

3.2.7. Bécasseau maubèche, *Calidris canutus*

Les principales aires d'hivernage du Bécasseau maubèche se trouvent en Terre de Feu et sur le littoral de la Patagonie en Argentine (carte 3.7). Peu de concentrations importantes ont été aperçues ailleurs; de petits nombres étaient présents dans le centre-nord du Brésil et l'ouest du Venezuela, et quelques observations ont été faites à des endroits épars sur la côte nord du Brésil.

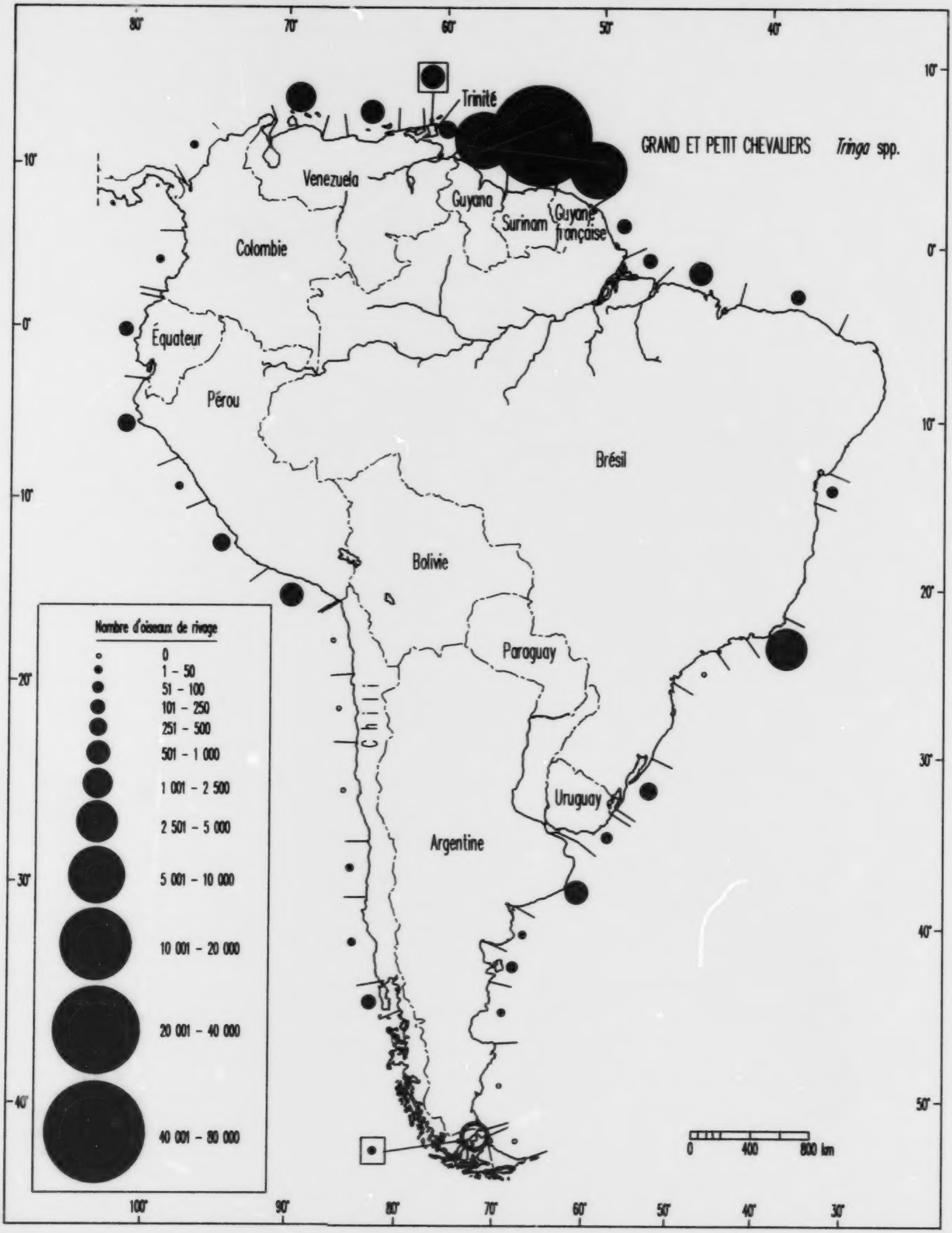
La baie Lomas est apparue l'emplacement de loin le plus important. Située près de l'entrée est du détroit de Magellan sur la côte nord du secteur chilien de la Terre de Feu, elle offre une vaste étendue d'estrans vaseux, lisses ou à rigoles, adossés à des terrains plats herbeux. Vers la fin

Carte 3.5
Distribution des Tournepierres à collier, *Arenaria interpres*, sur les côtes de l'Amérique du Sud

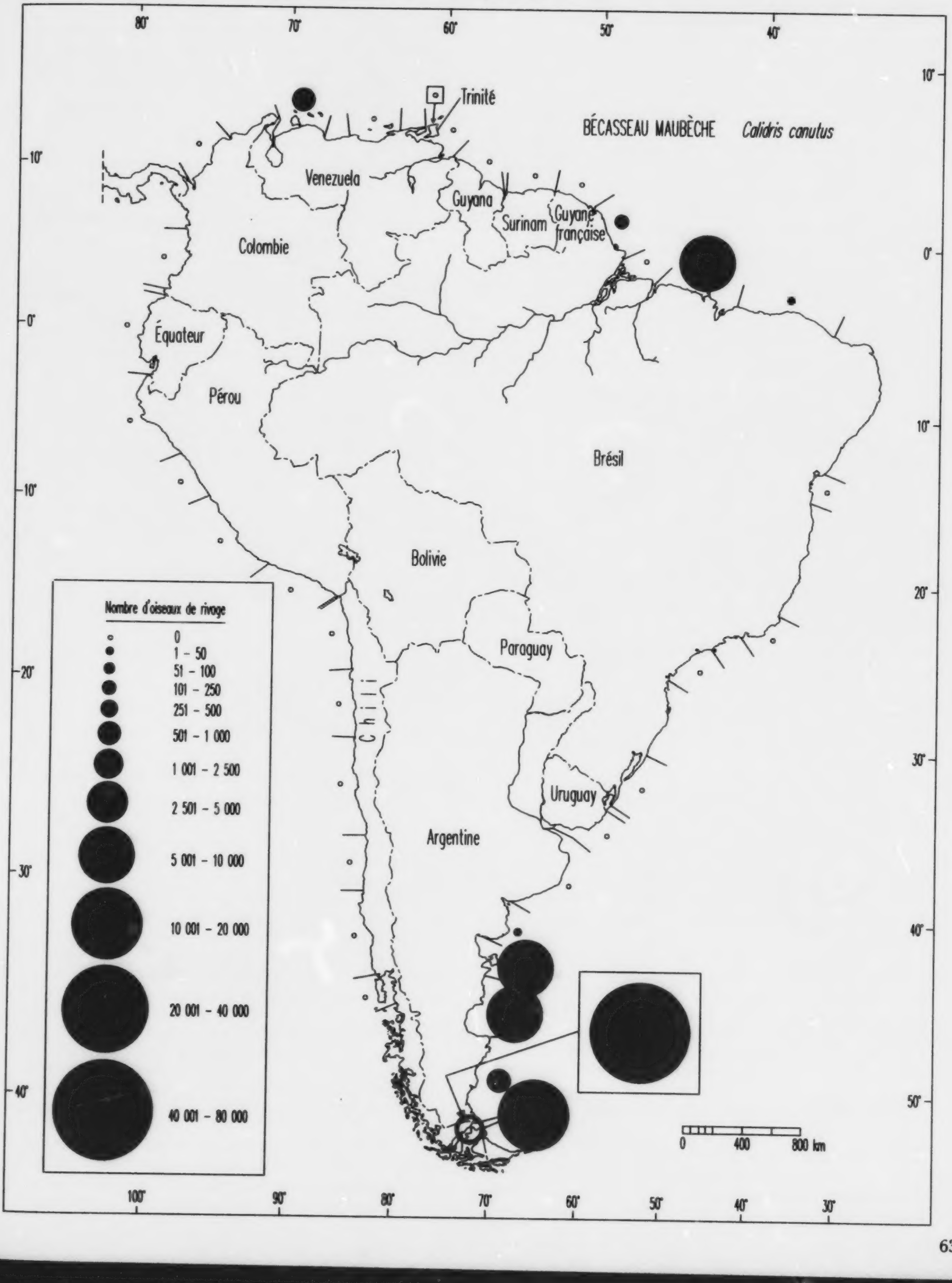


TOURNEPIERRE À COLLIER *Arenaria interpres*
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Carte 3.6
Distribution des Grands et Petits Chevaliers, *Tringa* spp., sur les côtes de l'Amérique du Sud


GRAND ET PETIT CHEVALIERS *Tringa* spp.
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Carte 3.7
Distribution des Bécasseaux maubèches, *Calidris canutus*, sur les côtes de l'Amérique du Sud


BÉCASSEAU MAUBÈCHE *Calidris canutus*
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
400
800 km
80°
70°
60°
50°
40°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°
50°
10°
0°
10°
20°
30°
40°

de janvier 1985, on y a compté 41 700 Bécasseaux maubèches, soit 54,6 % du nombre total de ces bécasseaux recensés en Amérique du Sud. D'autres concentrations importantes ont été observées près de Rio Grande (5 100 individus) et près de la baie San Sebastian (4 440) sur la côte argentine de la Terre de Feu. À Rio Grande, les maubèches s'alimentaient sur les grandes étendues rocheuses (*restingas*) exposées aux marées et elles utilisaient comme lieu de repos la levée de galets de la pointe Popper ou la plage de Rio Grande. À la baie San Sebastian, elles fréquentaient les vastes estrans vaseux à rigoles et la longue levée de galets qui suit la côte. Au total, le secteur chilien de la Terre de Feu abritait près de 42 800 Bécasseaux maubèches, et le secteur argentin, quelque 10 500, soit 56,0 et 13,7 %, respectivement (ou 69,7 % ensemble), de l'effectif recensé en Amérique du Sud.

D'autres groupes importants ont été observés hivernant sur les rivages de la Patagonie en Argentine autour du golfe de San Jorge et de la presqu'île de Valdés. L'unité écologique du golfe de San Jorge abritait 8 700 Bécasseaux maubèches (11,4 % du nombre total pour l'Amérique du Sud), qui fréquentaient plus particulièrement la région de la baie Bustamante (7 400) et la *restinga* au sud de Comodoro Rivadavia entre Caleta Olivia et Cabo Blanco (1 300). Avec plus de 5 000 individus (6,6 % du total pour l'Amérique du Sud), l'unité écologique de la presqu'île de Valdés constitue une autre zone importante. Des groupes de maubèches y ont été observés à un certain nombre d'endroits autour de la presqu'île : 1 200 vers le nord près de Puerto Lobos sur les rivages du golfe San Matias; 1 000 près de Caleta Valdés; 2 000 près de Punta Delgada; 300 et 500 près de l'entrée du golfe Nuevo. Le golfe de San José, situé du côté nord de la presqu'île, n'a pas été couvert lors des recensements pour des raisons logistiques, même s'il constitue une halte importante durant les migrations vers le nord (Harrington, 1982; Morrison, 1984). Des concentrations plus faibles ont été aperçues plus bas sur la côte de la Patagonie, au sud de Puerto Deseado, près de Punta Medanosa (400) et de Cabo Danaso (150). Les 67 500 Bécasseaux maubèches hivernant sur la côte Atlantique, soit 88,4 % de leur nombre total recensé en Amérique du Sud, ont tous été observés entre la Terre de Feu et le fleuve Colorado (Argentine).

Les autres Bécasseaux maubèches recensés se trouvaient sur la côte nord du continent (11,6 %). La plupart ont été aperçus dans la partie du centre-nord de la côte brésilienne (8 200 individus ou 10,7 % du total pour l'Amérique du Sud) et ils étaient divisés principalement en deux groupes de 5 000 et 3 000 individus qui partageaient la région de São Luis, région très productive où la côte découpée offre une grande variété d'habitats vaseux et sableux pour l'alimentation et le repos et qui est également importante pour divers autres oiseaux, plus particulièrement des espèces de moyenne et grosse taille. La seule autre concentration notable (520 individus) a été observée dans l'ouest du Venezuela à l'exutoire du lac Maracaibo près des côtes du golfe de Venezuela.

Aucun Bécasseau maubèche n'a été identifié sur la côte du Pacifique de l'Amérique du Sud durant les relevés aériens, mais de petits nombres y ont été aperçus lors des relevés au sol (résultats inédits; p. ex., Hughes, 1976).

3.2.8. Bécasseaux, *Limnodromus* spp.

Il n'est pas possible de distinguer des airs les deux espèces du genre *Limnodromus*; toutefois, comme on pense que très peu de Bécasseaux à long bec (*L. scolopaceus*) se rendent en Amérique du Sud et peut-être même aucun (Blake, 1977), il est probable que tous les bécasseaux de ce genre observés lors des relevés étaient des Bécasseaux roux (*L. griseus*).

L'aire de distribution de ces bécasseaux en Amérique du Sud est clairement limitée à la partie nord du continent, la côte nord surtout où 97,1 % des 49 000 individus observés au total se trouvaient (carte 3.8). Le reste (2,9 %) a été aperçu sur la côte du Pacifique, mais pas plus bas que l'Équateur : aucune observation n'a été faite plus au sud ni sur la côte Atlantique.

Les bécasseaux du genre *Limnodromus* fréquentaient principalement les côtes à mangrove dotées de vastes estrans et les lagunes côtières. Ils étaient particulièrement concentrés à de tels endroits au Surinam où se trouvaient 44,7 % de l'effectif sud-américain recensé. Des habitats similaires dans les pays voisins de la Guyana (5,9 %) et de la Guyane française (4,9 %) abritaient aussi de fortes concentrations. La deuxième zone en importance était le centre-nord de la côte brésilienne entre Belém et São Luis où 8 100 individus (16,6 %) ont été aperçus dans les mangroves et sur les estrans de cette portion très déchiquetée de la côte. Les nombres étaient également élevés aux lagunes de la côte centrale du Venezuela (7 100 ou 14,6 %), notamment à l'ouest de Barcelona et surtout à la lagune Chacopata. Ailleurs, les observations sont été faites à des endroits présentant des caractéristiques similaires : côtes à mangrove du delta de l'Orénoque (3 100 ou 6,3 %), lagunes de la côte caraïbe de la Colombie (1 600 ou 3,2 %) et littoraux à mangrove ou échancrures de la côte du Pacifique en Colombie (600 ou 1,2 %) et en Équateur (830 ou 1,7 %).

3.2.9. Oiseaux de rivage de grosse taille

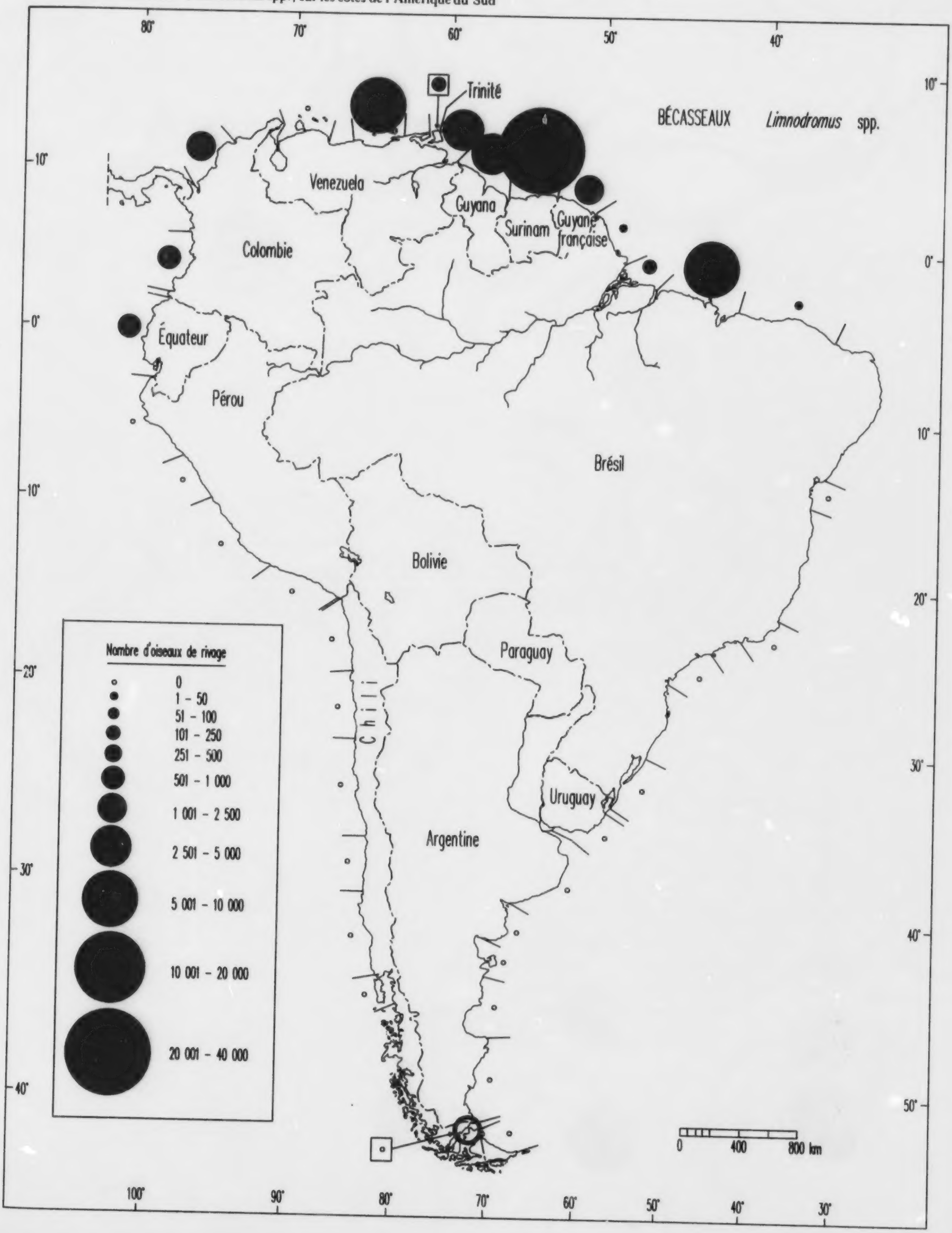
Le nombre de gros oiseaux de rivage recensés s'élève à plus de 121 000, ce qui représente environ 4,2 % du grand total des 2,9 millions d'oiseaux de rivage de la région néarctique dénombrés (tableau 3.2). Plusieurs zones de concentration ont été observées — le Surinam, le centre-nord de la côte brésilienne, la Terre de Feu et la zone de Chiloé — et ces zones tendent à refléter la distribution de différentes espèces (carte 3.9).

3.2.10. Chevalier semipalmé, *Catoptrophorus semipalmatus*

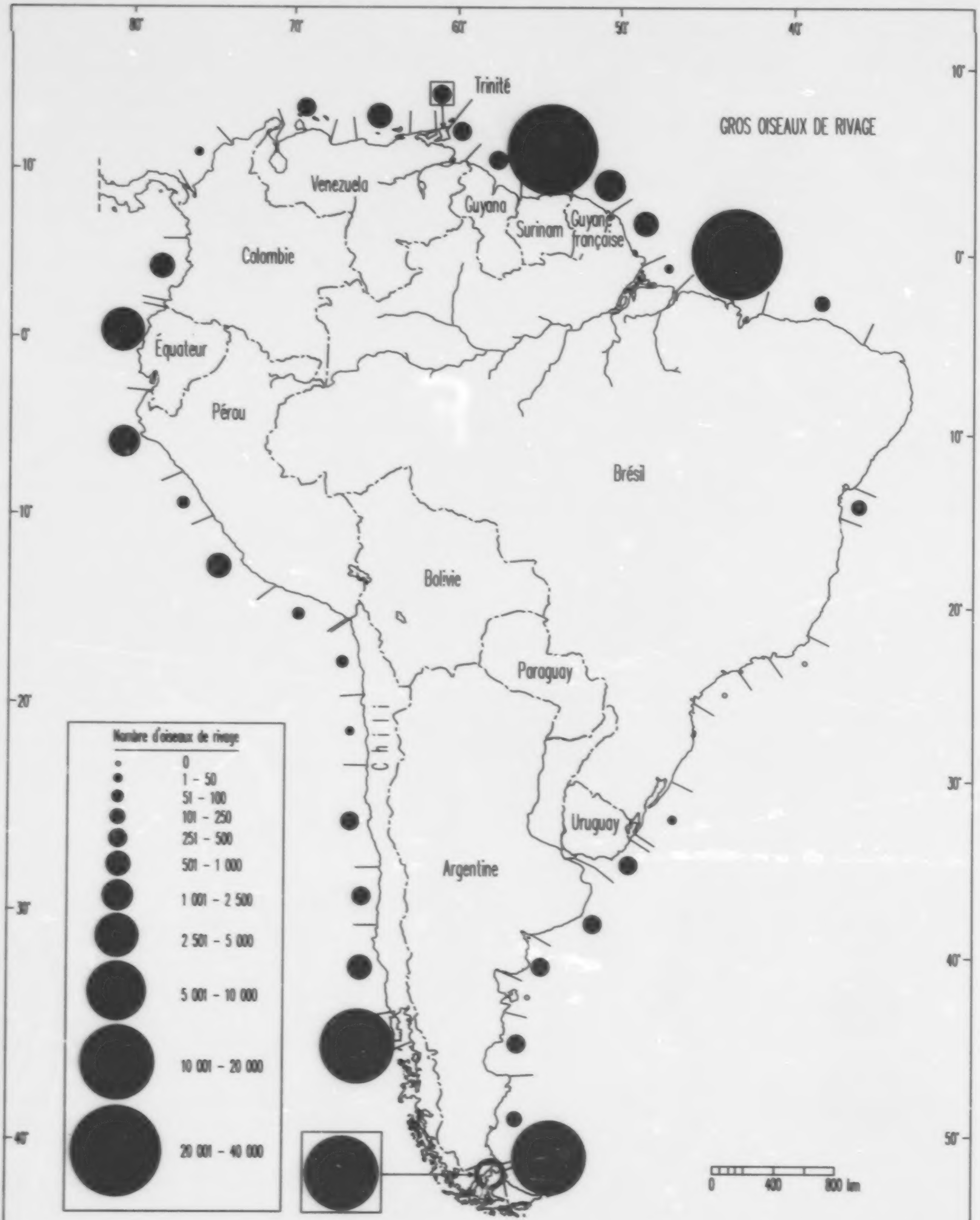
Les principales aires d'hivernage des Chevaliers semipalmés en Amérique du Sud se trouvent sur la côte nord du continent où 89,3 % des 44 400 individus recensés de cette espèce ont été observés. (carte 3.10). Ceux-ci fréquentaient les côtes à mangrove offrant de vastes étendues intertidales ainsi que des bancs et estrans vaseux durs. Il y a de nombreux habitats de cette nature sur la longue côte fortement découpée du centre-nord du Brésil qui abritait à peu près la moitié (49,3 %) de l'effectif recensé de l'espèce en Amérique du Sud et qui représentait pour elle la plus importante zone d'hivernage. Le Surinam, qui renferme également de tels habitats sur de grandes étendues, se classait au deuxième rang avec 35,3 % de l'effectif total. Les Chevaliers semipalmés étaient présents en nombres plus faibles presque partout ailleurs sur la côte nord, mais pas à l'embouchure de l'Amazone où aucun n'a été aperçu (tableau 3.3).

La répartition des Chevaliers semipalmés sur les côtes de l'Atlantique et du Pacifique était limitée par la distribution des mangroves, quoiqu'un certain nombre d'individus s'étaient dispersés plus au sud sur les côtes

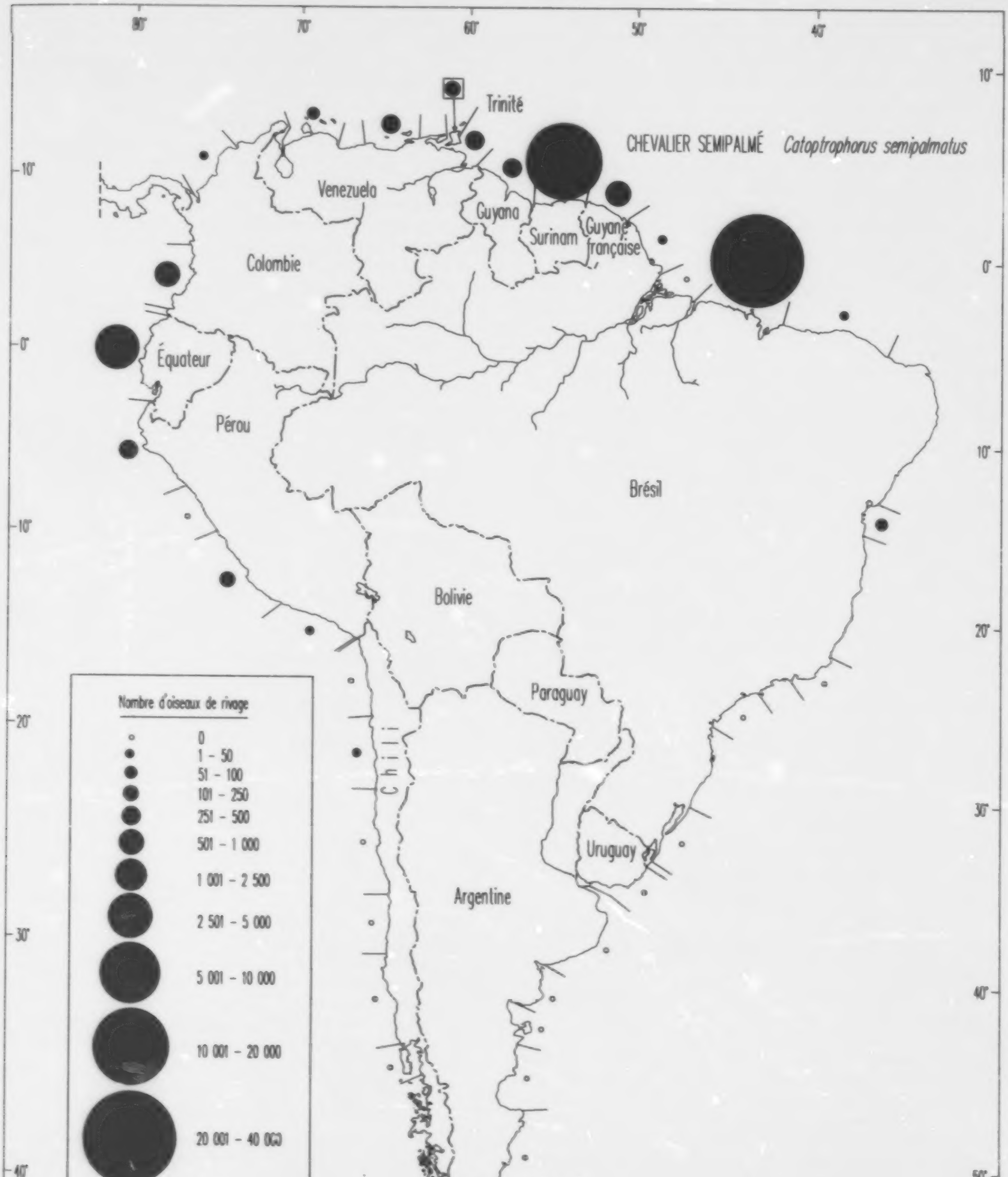
Carte 3.8
Distribution des bécasseaux, *Limnodromus* spp., sur les côtes de l'Amérique du Sud


BÉCASSEAUX *Limnodromus* spp.
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Carte 3.9
Distribution des gros oiseaux de rivage sur les côtes de l'Amérique du Sud


GROS OISEAUX DE RIVAGE
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Carte 3.10
Distribution des Chevaliers semipalmés, *Catoptrophorus semipalmatus*, sur les côtes de l'Amérique du Sud


CHEVALIER SEMIPALMÉ *Catoptrophorus semipalmatus*
Trinité
Venezuela
Colombie
Guyana
Surinam
Guyane française
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
100°
90°
30°
10°
0°
20°

du Pérou et du nord du Chili. Sur la côte Pacifique de la Colombie, les chevaliers se trouvaient dans les échancrures du rivage bordées par la mangrove (1,5 %), plus particulièrement entre la baie de Buenaventura et la frontière équatorienne. En Équateur (3 400 individus; 7,6 %), la plupart des Chevaliers semipalmés ont été aperçus sur les côtes à mangrove du golfe de Guayaquil (1 900) ou dans les échancrures de la côte où il existe des ensembles de mangroves, comme dans la baie de Caraquez (1 200). Au Pérou (590 individus recensés ou 1,3 % du total), la plupart des observations ont été faites au nord dans des mangroves (Tumbes, 22), des ensembles de zones humides (Sechura, 170) ou des estuaires (Virrila, 200), quoiqu'un certain nombre d'oiseaux ont été aperçus plus au sud, jusqu'au nord du Chili, sur des plages, souvent à des endroits où il y avait des ruisseaux ou des zones humides.

Sur la côte de l'Atlantique, les Chevaliers semipalmés n'ont pas été observés au sud de la région de Salvador où ils ont été aperçus en faibles nombres (80 ou 0,2 %) dans des échancrures de la côte et des baies bordées par la mangrove (baie de Todos os Santos, Valença, Itubera).

3.2.11. Barge hudsonienne, *Limosa haemastica*

Les principales aires côtières d'hivernage des Barges hudsoniennes se trouvent à l'extrémité sud du continent. Deux zones centrales de concentration ont été mises en évidence : la Terre de Feu, constituant la plus importante, et les environs de l'île de Chiloé dans le sud du Chili (carte 3.11). Des plus de 45 500 Barges hudsoniennes recensées, 71,9 % se trouvaient sur la côte de l'Atlantique, et 28,1 %, sur la côte du Pacifique.

Les plus importantes concentrations ont été observées en Terre de Feu, soit près de 19 500 individus (42,8 % du total pour l'Amérique du Sud) en Argentine et près de 11 700 (25,6 %) au Chili. L'emplacement le plus important y était la baie San Sebastian, en Argentine, sur la côte Atlantique, où 19 400 barges ont été observées sur les vastes estrans vaseux à rigoles, protégés par la longue levée de galets de 18 km de la presqu'île El Paramo. À ce seul emplacement se trouvaient quelque 42,5 % de l'effectif total recensé en Amérique du Sud, ce qui en fait une zone d'importance internationale exceptionnelle. Le reste des barges qu'abritait la partie argentine de la Terre de Feu se trouvaient sur des bancs bordant la côte de l'Atlantique (*restingas*). Le deuxième emplacement le plus utilisé était la baie Lomas, importante aire d'hivernage des Bécasseaux maubèches, qui se trouve à quelque 60 km au nord de l'entrée est du détroit de Magellan. On a recensé 10 500 barges (23,1 %) sur les vastes estrans lisses et à rigoles de cette baie. Le reste des barges (1 140) observées dans la partie chilienne de la Terre de Feu se trouvaient en face de l'entrée de la baie sur le côté nord du détroit de Magellan.

Plus au nord, les barges ont été observées en nombres plus faibles ici et là sur la côte de l'Atlantique aussi haut que l'Uruguay. Aux emplacements méridionaux de la côte de la Patagonie, en Argentine, la plupart des barges se trouvaient sur des bancs côtiers (*restingas*), par exemple près de Puerto Deseado (160) et plus au sud sur les bords de Caleta Olivia (350) au sud de Comodoro Rivadavia. Dans la partie nord du littoral de l'Argentine, les barges ont été aperçues dans des milieux estuariens, par exemple sur les vastes estrans de la baie Union et de la baie Anegada (310) au sud de l'exutoire du fleuve Colorado et sur les estrans de la partie sud de la baie Samborombon (430) à l'ouest de Punta Rasa dans la province de Buenos Aires. En Uruguay, les barges ont surtout été observées dans des lagunes d'eau douce et d'eau saumâtre, y compris celles de Rocha (215), de Castillos (50) et de Mirim (60). Même si l'espèce utilise des habitats intérieurs et lagunaires en Uruguay et dans la province de Buenos Aires (Myers et Myers, 1979), les principales aires d'hivernage reconnues lors des relevés se trouvaient sur la côte de la partie sud du continent.

Des concentrations importantes ont également été observées dans la zone de Chiloé où se trouvaient plus de 12 600 (27,8 % de l'effectif sud-américain) des 12 800 barges dénombrées sur la côte du Pacifique. La majorité se trouvaient dans l'île de Chiloé, surtout dans les échancrures du rivage donnant sur le golfe d'Ancud, où les totaux pour les différents secteurs de recensement variaient de 250 à environ 2 000. Les barges étaient abondantes (2 900) dans des échancrures similaires de la côte à l'ouest de Puerto Montt et dans un large delta à l'est de la même ville sur la côte nord du golfe d'Ancud. Même si beaucoup des échancrures du rivage se caractérisent par des flancs assez raides, elles renferment souvent des deltas ou complexes marécageux importants dans leur partie amont, qui sont parfois associés à des estrans vaseux, et c'est dans de tels habitats que la plupart des barges ont été observées.

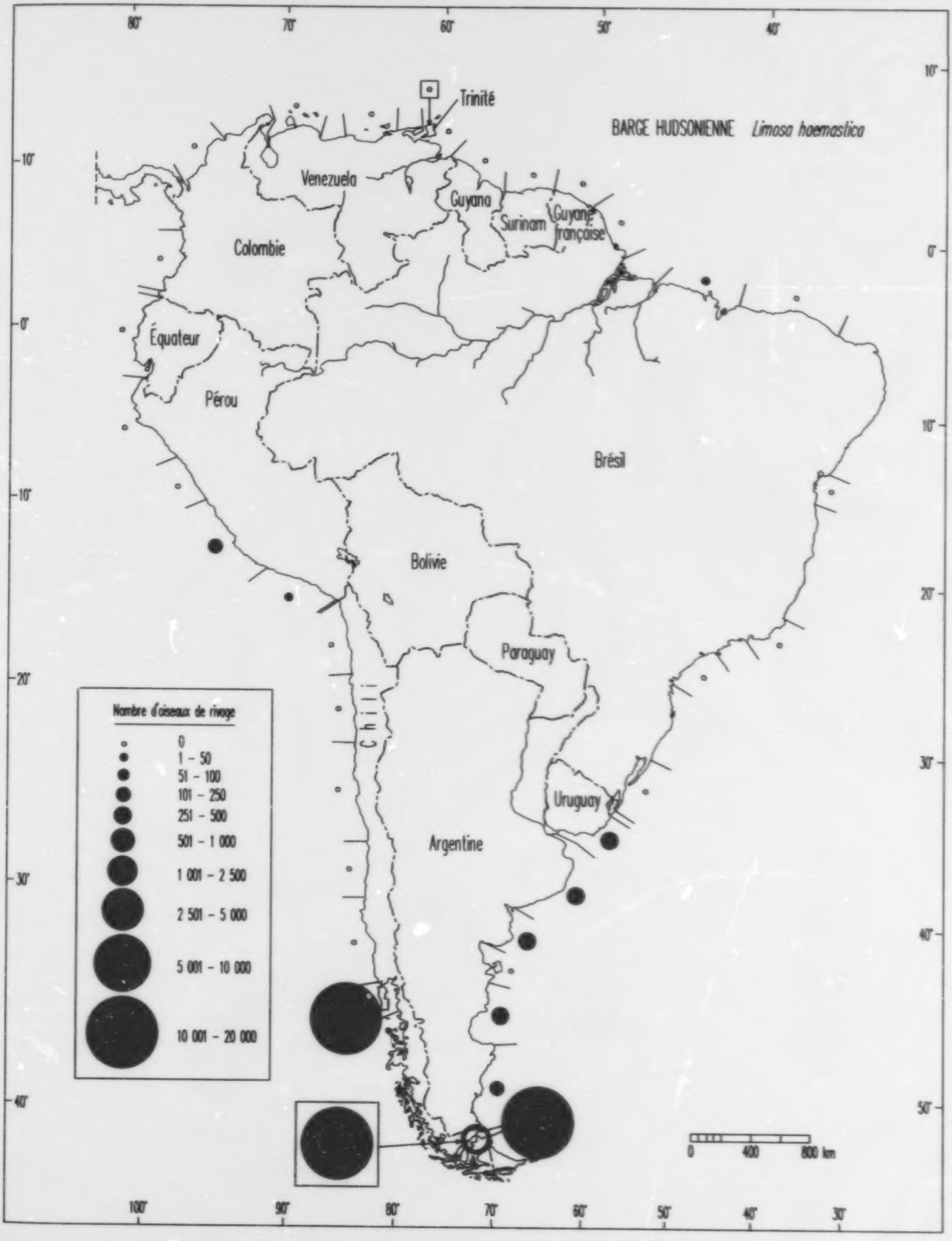
Ailleurs, les barges étaient peu nombreuses et très dispersées, la concentration la plus notable étant de 170 individus dans la région de la rivière Pisco dans le centre-sud de la côte péruvienne.

La migration des Barges hudsoniennes est l'une des plus spectaculaires qu'on connaisse. Il n'y a pas si longtemps, dans les années 40, on croyait que l'espèce était au bord de l'extinction en raison des nombres relativement faibles qui étaient — et sont encore — observés sur la côte est de l'Amérique du Nord. À partir de leurs lieux de reproduction dans la région centrale de l'Arctique canadien, les barges se rassemblent avant leur migration en nombres très élevés sur les côtes de la baie d'Hudson et de la baie James, comme l'ont indiqué les observations initiales de certains ornithologues (Hope et Shortt, 1944) et l'ont confirmé plus tard des relevés aériens plus vastes qui ont permis de découvrir des rassemblements comptant jusqu'à 10 000 oiseaux à un seul endroit. (Morrison et Harrington, 1979; Morrison, 1983 et 1984). En quittant la baie James, les barges s'en vont directement en Amérique du Sud (Hagar, 1966) : l'endroit le plus proche de là où des nombres élevés ont été signalés est dans la province de Buenos Aires en Argentine, quoique les calendriers de migration semblent indiquer l'existence d'une halte non encore découverte quelque part dans la partie nord de l'Amérique du Sud (Morrison, 1984). Il semble donc probable que les populations hivernant en Terre de Feu proviennent des lieux de reproduction du centre de l'Arctique canadien. Il n'a pas encore été établi si les populations hivernant dans la région de Chiloé se reproduisent dans l'ouest de l'Arctique et en Alaska.

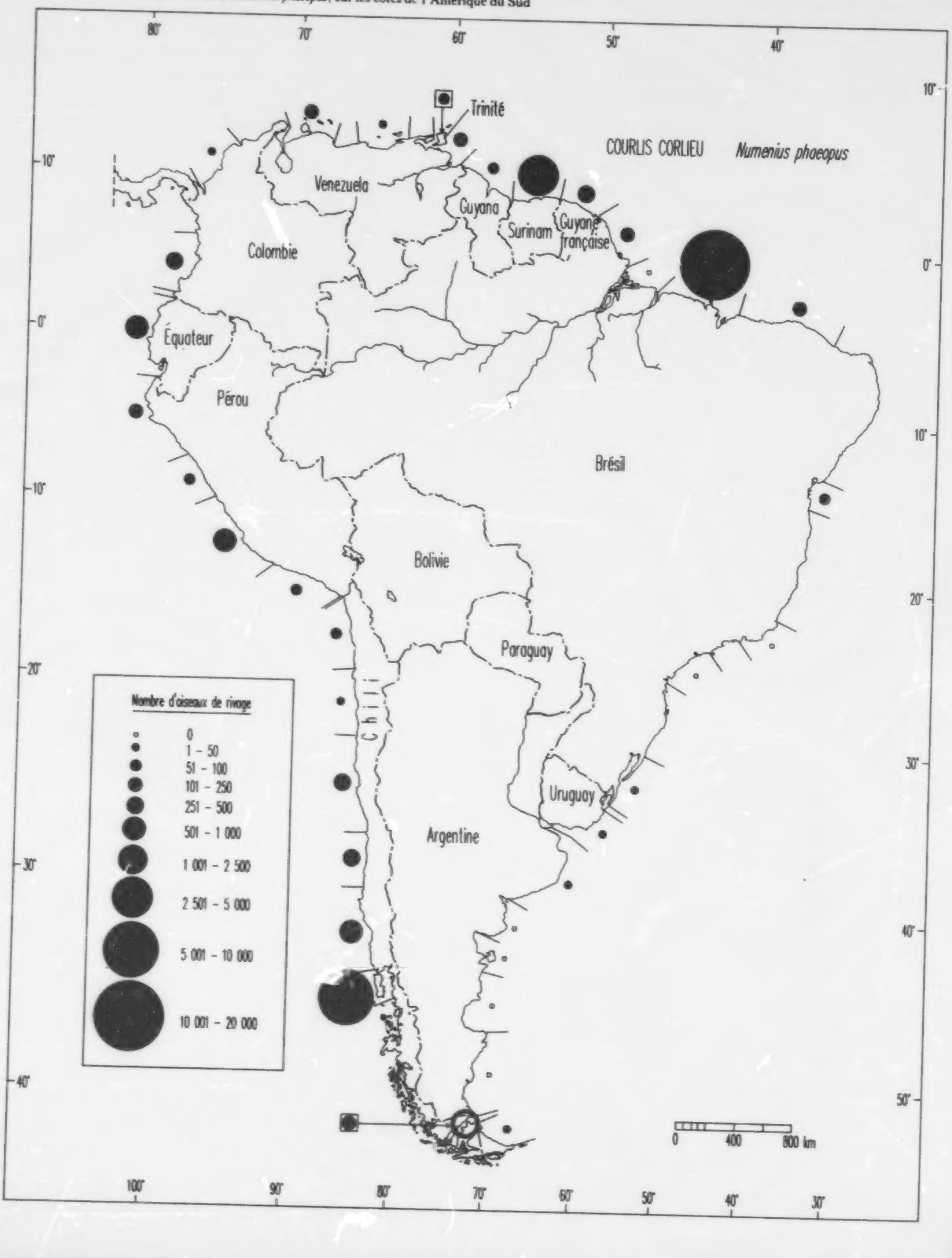
3.2.12 Courlis corlieu, *Numenius phaeopus*

Les Courlis corlieux étaient assez largement distribués en Amérique du Sud; cependant, trois grandes zones de concentration ont été mises en évidence par les recensements : le centre-nord de la côte du Brésil, le Surinam et l'île de Chiloé au Chili (carte 3.12). La majorité (61,3 %) des 24 900 courlis recensés se trouvaient sur la côte nord du continent; beaucoup (37,8 %) ont également été observés sur la côte du Pacifique, mais ils étaient plus rares sur la côte de l'Atlantique (0,8 %).

Carte 3.11
Distribution des Barges hudsoniennes, *Limosa haemastica*, sur les côtes de l'Amérique du Sud


BARGE HUDSONIENNE *Limosa haemastica*
Trinité
Venezuela
Guyana
Surinam
Guyane française
Colombie
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Carte 3.12
Distribution des Courlis corlieux, *Numenius phaeopus*, sur les côtes de l'Amérique du Sud


COURLIS CORLIEU *Numenius phaeopus*
Trinité
Venezuela
Colombie
Guyana
Surinam
Guyane française
Équateur
Pérou
Brésil
Bolivie
Paraguay
Chili
Uruguay
Argentine
Nombre d'oiseaux de rivage
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°
50°
10°
0°
10°
20°
30°
40°

Sur la côte nord, les courlis étaient présents aux endroits où l'on trouvait de vastes estrans et mangroves, surtout dans les zones de bancs et d'estrans vaseux durs. Les habitats de ce genre sont abondants dans le centre-nord de la côte brésilienne, où se trouvaient 43,7 % des courlis recensés en Amérique du Sud (71,3 % du total de 15 300 pour la côte nord), ainsi qu'au Surinam (13,3 % du total pour le continent). Les courlis fréquentaient des habitats similaires, mais en nombres plus faibles, ailleurs sur la côte nord.

Sur la côte du Pacifique, les plus fortes concentrations ont été observées dans la région de Chiloé (6 200 individus ou 25,0 % du total pour l'Amérique du Sud). L'espèce était répandue dans le nord et, plus particulièrement, l'est de l'île de Chiloé, dans les échancrures du rivage faisant face au golfe d'Ancud. On y a recensé de 30 à près de 700 courlis par secteur d'étude, pour un total de plus de 2 800. Beaucoup des échancrures de la côte contiennent des deltas marécageux ou des zones humides de petite à assez grande étendue qui sont parfois associés à des estrans vaseux; les courlis ont été observés à de tels endroits. La plus forte concentration (1 100) a été découverte dans une de ces échancrures de la côte à l'ouest de Puerto Montt, tandis qu'une autre concentration importante (740) se trouvait dans le vaste complexe estuarien aux environs de Maullin.

Les courlis étaient répartis en nombres plus faibles partout ailleurs sur la côte du Pacifique où ils utilisaient des habitats variés, principalement les plages océaniques se trouvant plus au nord, sur la côte du Chili et au Pérou (930 individus ou 3,8 %). En Équateur (560 individus ou 2,3 %) et sur la côte Pacifique de la Colombie (320 individus ou 1,3 %), les courlis étaient là aussi plus répandus sur les littoraux à mangrove présentant des substrats vaseux durs, plus particulièrement dans la partie est de la côte intérieure du golfe de Guayaquil et en Colombie entre la frontière de l'Équateur et la baie de Buenaventura.

Sur la côte de l'Atlantique, les courlis, qui y étaient moins nombreux, fréquentaient principalement les habitats à mangrove de la région de Salvador, au Brésil, et les baies et échancrures du rivage de la région du détroit de Magellan, au Chili.

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Capítulo 3

Sobrevuelo

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3.1. Patrones generales de distribución de aves de orilla marina en América del Sur

La evaluación comprendió apróximadamente 28 000 km de línea costera de América del Sur, e incluyen todos los trechos de costa que contienen hábitats significativos para aves de orilla marina (ver capítulo 2). Más de 2.9 millones de aves de orilla marina neárticas, fueron contadas durante la evaluación: los totales son resumidos por países para las tres mayores categorías de tamaño en la Tabla 3.1. Las especies pequeñas fueron numéricamente predominantes (para la composición de especies de cada categoría de tamaño, ver capitulo 2), comprendiendo 79.7% del total, las de tamaño medio y de tamaño grande que alcanzan 15.7% y 4.2%, respectivamente.

Las aves no categorizadas hacen un 0.4% del total. Solamente sobre la base de los números, la costa norte de América del Sur, fue claramente la más importante área de invernada para aves de orilla marina, llegando cercanamente a los 2.5 millones, o 85.6% del total para América del Sur, y conteniendo la costa del Pacífico 218 000 (7.5%) y la costa atlántica 203 000 (7.0%) (Tabla 3.2.). Estos resultados reflejan la abundancia de aves de orilla marina, en la costa norte, y otras áreas de gran significado para otros grupos de especies o especies individuales. En la costa norte, la distribución de pequeñas especies se concentró en las Guyanas con Surinam (57.9%) y Guyana Francesa (16.9%), conteniendo juntas cerca al 75% del total de América del Sur; otras áreas importantes incluyeron Brasil (10.9%) y partes de Perú (3.9%), Chile (2.2%) y Argentina (1.8%). Para aves de orilla marina de tamaño mediano, la costa norte fue también importante: 42.2% del total de América del Sur ocurrieron en las Guyanas (Surinam 32.4%, Guyana Francesa 7.2%, Guyana 2.5%), con substanciales cantidades invernando en Brasil (24.1%), Chile (9.7%), Venezuela (7.1%), Argentina (6.6%), y Perú (5.1%). Brasil tiene los más altos porcentajes para especies de tamaño grande con 29.0%, otras importantes áreas de invernada para especies de este grupo incluyen a Chile (26.4%), Surinam (17.8%), y Argentina (17.2%).

3.2. Distribución de los grupos mayores y especies de aves de orilla marina neárticas en América del Sur

Al describir los patrones de distribución de aves de orilla marina, en América del Sur, la línea costera fue dividida en 36 eco-unidades, cada una de las cuales representó una unidad geográfica, ecológica y/o política, con un carácter ecológico distintivo (ver Fig. 2.2., capítulo 2). El total de aves de orilla marina ocurridas en cada eco-unidad, están resumidas por 3 categorías de 2 tamaños en la Tabla 3.2. y por especies en las Tablas 3.3*a–c*. Los patrones de distribución por diferentes categorías de tamaños y especies están ilustrados en los mapas 3.1–3.12. La situación de las principales áreas de invernada se muestran en el interior de la tapa delantera.

3.2.1. Pequeñas aves de orilla marina

La distribución de pequeñas aves de orilla marina se muestra en el mapa 3.1. Este grupo estuvo conformado por pequeños playeros del género *Calidris*, así como también por chorlos del género *Charadrius*. Generalmente impracticable identificarlos desde el aire dada la gran cantidad de las especies de este grupo, con la excepción del playero blanco *Calidris alba*, el cual pudo ser contado separadamente debido a su distinta apariencia y características de ocurrencia en los hábitats de las playas (ver sección 3.2.2.). El playero manchado *Actitis macularia* podía ser frecuentemente identificado en las líneas costeras de los manglares en áreas de baja densidad de aves, aunque la separación era impracticable en grandes bandadas de especies mixtas ocurridas.

Eludiendo estos factores que afectaron la identificación, tanto las observaciones aéreas como terrestres, indicaron que bandadas grandes de piadores (pequeños playeros) ocurridas en diferentes regiones del continente, usualmente estuvieron conformadas predominantemente por especies solitarias. Este fue el caso del playerito semipalmado *Calidris pusilla* en la costa norte, mientras que en la mitad sur de la costa atlántica, desde el sur de Brasil hacía Tierra del Fuego, la mayoría de piadores fueron del playero de lomo blanco *C. fuscicollis*. Los patrones muestran en el mapa 3.1. que estas dos regiones deberían tomarse como representativas de la distribución de las dos especies en América del Sur.

Un número general de estas facciones se encuentran en el mapa 3.1. Grandes cantidades de pequeños playeros, mayormente del playerito semipalmado, ocurrieron en la costa norte del continente, principalmente en Surinam y las Guyanas. De un total de 2 083 000 de piadores en la costa norte de América del Sur, 64.6% fueron encontrados en Surinam, con un 18.9% en la Guyana Francesa y 0.5% en Guyana, conteniendo las Guyanas un 84% del total. Otras áreas importantes de la costa norte, incluyen la costa nor-central de Brasil, la cual contiene 9.2% del total y el delta del Orinoco en Venezuela con más de 3.3%.

Tabla 3.1
Totales por país de las aves de orilla marina contadas durante los reconocimientos aéreos de la costa de América del Sur, 1982-1986

País/Parámetro	Longitud área reconocida (km)	Aves de orilla marina pequeñas	Aves de orilla marina de tamaño medio	Aves de orilla marina de tamaño grande	Aves de orilla marina no clasificadas	Total de aves de orilla marina
Venezuela	1 938.0					
Numéro de aves		94 476	32 473	1 405	1 411	129 765
% del total de la categoría de tamaño (América del Sur)		4.06	7.10	1.16	10.77	4.45
% del total general (América del Sur)		3.24	1.11	0.05	0.05	4.45
Trinidad	483.8					
Número de aves		12 393	986	259	0	13 638
% del total de la categoría de tamaño (América del Sur)		0.53	0.22	0.21	0.00	0.47
% del total general (América del Sur)		0.42	0.03	0.01	0.00	0.47
Guyana	478.5					
Número de aves		9 808	11 618	340	0	21 766
% del total de la categoría de tamaño (América del Sur)		0.42	2.54	0.28	0.00	0.75
% del total general (América del Sur)		0.34	0.40	0.01	0.00	0.75
Surinam	369.8					
Número de aves		1 346 625	148 168	21 536	10 000	1 526 329
% del total de la categoría de tamaño (América del Sur)		57.85	32.42	17.75	76.31	52.28
% del total general (América del Sur)		46.13	5.08	0.74	0.34	52.28
Guyana Francesa	388.2					
Número de aves		394 334	32 906	2 094	1 500	430 834
% del total de la categoría de tamaño (América del Sur)		16.94	7.20	1.73	11.45	14.76
% del total general (América del Sur)		13.51	1.13	0.07	0.05	14.76
Brasil	7 852.5					
Número de aves		252 812	110 258	35 147	0	398 217
% del total de la categoría de tamaño (América del Sur)		10.86	24.12	28.97	0.00	13.64
% del total general (América del Sur)		8.66	3.78	1.20	0.00	13.64
Uruguay	621.9					
Número de aves		3 137	6 960	422	0	10 519
% del total de la categoría de tamaño (América del Sur)		0.13	1.52	0.35	0.00	0.36
% del total general (América del Sur)		0.11	0.24	1.01	0.00	0.36
Argentina	4 549.0					
Número de aves		41 429	30 195	20 306	194	92 624
% del total de la categoría de tamaño (América del Sur)		1.78	6.61	17.55	1.48	3.17
% del total general (América del Sur)		1.42	1.03	0.71	0.01	3.17
Chile	5 487.5					
Número de aves		51 186	44 432	32 019	0	127 637
% del total de la categoría de tamaño (América del Sur)		2.20	9.72	26.39	0.00	4.37
% del total general (América del Sur)		1.75	1.52	1.10	0.00	4.37
Perú	2 774.3					
Número de aves		89 675	23 367	2 234	0	115 276
% del total de la categoría de tamaño (América del Sur)		3.85	5.11	1.84	0.00	3.95
% del total general (América del Sur)		3.07	0.80	0.08	0.00	3.95
Ecuador	1 385.5					
Número de aves		2 274	3 485	4 006	0	9 765
% del total de la categoría de tamaño (América del Sur)		0.10	0.76	3.30	0.00	0.33
% del total general (América del Sur)		0.08	0.12	0.14	0.00	0.33
Colombia	1 600.6					
Número de aves		29 673	12 238	1 049	0	42 960
% del total de la categoría de tamaño (América del Sur)		1.27	2.68	0.86	0.00	1.47
% del total general (América del Sur)		1.02	0.42	0.04	0.00	1.47
Total	27 929.6	2 327 822	457 086	121 317	13 105	2 919 330
% del total general (América del Sur)		79.74	15.66	4.16	0.45	100.00

Tabla 3.2
Resumen por categoría de tamaño de las aves de orilla marina neárticas en las regiones y en las eco-unidades a lo largo de la costa de América del Sur

Región/Eco-unidad	Eco-un. longitud (km)	Aves de orilla marina pequeñas	Aves de orilla marina de tamaño medio	Aves de orilla marina de tamaño grande	Aves de orilla marina no clasificadas	Total de aves de orilla marina
Costa Norte						
Colombia - Caribe	853.7	4 955	6 014	50	0	11 019
Venezuela - Caribe Occidental	1 113.2	9 640	10 205	406	1 411	21 662
Venezuela - Caribe Central	275.6	15 203	8 240	519	0	23 962
Venezuela - Orinoco	549.2	69 633	14 028	480	0	84 141
Trinidad	483.8	12 393	986	259	0	13 638
Guyana	478.5	9 808	11 618	340	0	21 766
Surinam	369.8	1 346 625	148 168	21 536	10 000	1 526 329
Guyana Francesa	388.2	394 334	32 906	2 094	1 500	430 834
Brasil - Norte	464.3	25 598	2 323	674	0	28 595
Brasil - Amazonas	633.8	2 080	621	7	0	2 708
Brasil - Norte-Centro	2 504.7	195 531	97 227	34 133	0	326 891
Brasil - Noreste	1 248.4	3 009	2 760	183	0	5 952
Total regional (Costa norte)	9 363.2	2 088 809	335 096	60 681	12 911	2 497 497
Costa del Atlántico						
Brasil - Este	939.0	1 817	679	143	0	2 639
Brasil - Río	394.9	688	4 885	0	0	5 573
Brasil - São Paulo	784.5	11	1	0	0	12
Brasil - Río Grande do Sul	882.9	24 078	1 762	7	0	25 847
Uruguay	621.9	3 137	6 960	422	0	10 519
Argentina - Buenos Aires	921.8	1 625	1 994	482	103	4 204
Argentina - Río Colorado	910.5	4 967	1 846	318	0	7 131
Argentina - Península Valdés	784.9	1 815	5 086	0	1	6 902
Argentina - Golfo San Jorge	730.9	7 559	9 128	357	90	17 134
Argentina - Río Gallegos	770.9	1 700	550	163	0	2 413
Argentina - Tierra del Fuego	430.0	23 763	11 591	19 486	0	54 840
Chile - Tierra del Fuego	619.2	11 210	43 206	11 779	0	66 195
Total regional (Costa del Atlántico)	8 791.4	82 370	87 688	33 157	194	203 409
Costa del Pacífico						
Chile - Chiloé	1 432.0	19 164	789	18 856	0	38 809
Chile - Concepción	880.7	4 563	51	617	0	5 231
Chile - Valparaíso	543.0	9 166	87	384	0	9 637
Chile - La Serena	846.2	4 395	108	291	0	4 794
Chile - Antofagasta	582.8	1 327	128	33	0	1 488
Chile - Arica	583.6	1 361	63	59	0	1 483
Perú - Mollendo	683.9	14 854	6 393	81	0	21 328
Perú - Lima	792.7	19 995	2 335	988	0	23 318
Perú - Chimbote	426.1	2 171	435	65	0	2 671
Perú - Chiclayo	871.6	52 655	14 204	1 100	0	67 959
Ecuador	1 385.5	2 274	3 485	4 006	0	9 765
Colombia - Pacífico	746.9	24 718	6 224	999	0	31 941
Total regional (Costa del Pacífico)	9 775.0	156 643	34 302	27 479	0	218 424
Total	27 929.6	2 327 822	457 086	121 317	13 105	2 919 330

Relativamente pocos playeros pequeños fueron encontrados, en hábitats tropicales al norte de la parte media de la costa atlántica, a pesar de la presencia de estuarios o bahias con fango y formaciones de manglares en el área de Salvador. Un fenómeno similar fue notado en la mitad norte de la costa pacífica, donde muchas áreas conforman adecuados hábitats estuarinos, tales como el Golfo de Guayaquil y la Bahía de Buenaventura, conteniendo pocos playeros pequeños.

Estudios de anillamiento (Morrison y Spaans 1979, Spaans 1984), colecciones de museos (resultados no publicados), y observaciones de campo (Spaans 1978, 1979) han mostrado que la mayoría de playeros pequeños clasificados como piadores en la costa norte están conformados por el playerito semipalmado que también ocurre muy estrechamente relacionado con el playerito occidental *Calidris mauri*. Grandes cantidades de playeros occidentales están presentes en la migración de la costa oeste de Norte América (por ejemplo, Copper River delta y Fraser River delta; Senner *et al.* 1981). La proporción de playerito occidental, en las poblaciones de invernada de la costa norte es todavía baja, y relativamente pequeños números de piadores han estado invernando en la costa nor-oeste Pacífica de América del Sur. Esto sugiere que el significado de las áreas de invernada del playerito occidental sería el norte de América del Sur. Recientemente, grandes cantidades han sido halladas en Panamá (R.I.G. Morrison, R.K. Ross y F. Delgado; resultados no publicados; B.A. Harrington, J.P. Myers, com. pers.).

El playerito semipalmado muestra una variación en tamaño a lo largo de sus áreas de reproducción con las aves más grandes en el este Ártico y las más pequeñas en Alaska (Harrington y Morrison 1979). Esta variación se refleja de alguna manera en las mediciones de las aves, a través de la costa norte de América del Sur; las aves grandes invernan en la costa norte de Brasil y provienen de áreas de reproducción en el Ártico del este, y las aves pequeñas de la parte oeste de la costa norte y de la parte norte de la costa pacífica en vez de que vinieran de los sectores del oeste de las áreas de reproducción (Morrison 1983, 1984).

Moderadas concentraciones de playeros pequeños fueron encontrados en la mitad sur de la costa atlántica,

Tabla 3.3a
Totales de las especies de aves de orilla marina neárticas en las regiones y en las eco-unidades a lo largo de la costa del América del Sur—Aves de orilla marina pequeñas

Región/Eco-unidad	Eco-un. longitud (km)	Chorlo semi-palmado	Playero manchado	Pitoitoy solitario	Playero pectoral	Playero de lomo blanco	Playero blanco	Especies de aves pequeñas de orilla marina no identificadas	Total de aves pequeñas de orilla marina
Costa Norte									
Colombia - Caribe	853.7	0	28	0	0	0	56	4 871	4 955
Venezuela - Caribe Occidental	1 113.2	0	10	0	0	0	194	9 436	9 640
Venezuela - Caribe Central	275.6	0	1	0	0	0	0	15 202	15 203
Venezuela - Orinoco	549.2	0	7	0	0	0	460	69 166	69 633
Trinidad	483.8	0	21	0	0	0	5	12 367	12 393
Guyana	478.5	0	23	0	0	0	30	9 755	9 808
Surinam	369.8	0	10	0	0	0	42	1 346 573	1 346 625
Guyana Francesa	388.2	0	5	0	0	0	2	394 327	394 334
Brasil - Norte	464.3	0	2	0	0	0	2	25 594	25 598
Brasil - Amazonas	633.8	470	4	0	0	0	117	1 489	2 080
Brasil - Norte-Centro	2 504.7	0	246	1	0	0	3 080	192 204	195 531
Brasil - Noreste	1 248.4	0	3	0	0	0	380	2 626	3 009
Total regional (Costa Norte)	9 363.2	470	360	1	0	0	4 368	2 083 610	2 088 809
Costa del Atlántico									
Brasil - Este	939.0	0	20	1	65	0	261	1 470	1 817
Brasil - Río	394.9	0	2	0	0	0	524	162	688
Brasil - São Paulo	784.5	0	0	0	0	0	0	11	11
Brasil - Río Grande do Sul	882.9	0	0	0	1	2 340	6 618	15 119	24 078
Uruguay	621.9	0	3	0	0	1	5	3 128	3 137
Argentina - Buenos Aires	921.8	0	0	0	0	0	253	1 372	1 625
Argentina - Río Colorado	910.5	0	0	0	0	0	240	4 727	4 967
Argentina - Península Valdés	784.9	0	0	0	0	0	777	1038	1 815
Argentina - Golfo San Jorge	730.9	0	0	0	0	0	75	7 484	7 559
Argentina - Río Gallegos	770.9	0	0	0	0	0	0	1 700	1 700
Argentina - Tierra del Fuego	430.0	0	0	0	0	0	504	23 259	23 763
Chile - Tierra del Fuego	619.2	0	0	0	0	0	25	11 185	11 210
Total regional (Costa del Atlántico)	8 791.4	0	25	1	66	2 341	9 282	70 655	82 370
Costa del Pacífico									
Chile - Chiloé	1 432.0	0	0	0	0	0	10 194	8 970	19 164
Chile - Concepción	880.7	0	0	0	0	0	4 543	20	4 563
Chile - Valparaíso	543.0	0	0	0	0	0	8 442	724	9 166
Chile - La Serena	846.2	0	0	0	0	0	4 395	0	4 395
Chile - Antofagasta	582.8	0	0	0	0	0	1 327	0	1 327
Chile - Arica	583.6	0	0	0	0	0	1 361	0	1 361
Perú - Mollendo	683.9	0	1	0	0	0	14 242	611	14 854
Perú - Lima	792.7	0	1	0	0	0	18 831	1 163	19 995
Perú - Chimbote	426.1	0	8	0	0	0	2 163	0	2 171
Perú - Chiclayo	871.6	0	23	0	0	0	31 610	21 022	52 655
Ecuador	1 385.5	0	5	0	0	0	230	2 039	2 274
Colombia - Pacífico	746.9	0	8	0	0	0	827	23 883	24 718
Total regional (Costa del Pacífico)	9 775.0	0	46	0	0	0	98 165	58 432	156 643
Total	27 929.6	470	431	2	66	2 341	111 815	2 212 697	2 327 822

particularmente en Rio Grande do Sul al Sur de Brasil y en Tierra del Fuego (Argentina y Chile). Observaciones y estudios de anillamiento, han mostrado que pocos playeritos semipalmado ocurren más hacía el sur y que la mayoría de las aves son de playero de lomo blanco. Las más importantes áreas de invernada descubiertas estuvieron a lo largo de la costa atlántica de Tierra del Fuego en Argentina, la cual contiene 31.9% del total regional de 73 000 piadores; sectores chilenos de Tierra del Fuego que envuelven mayormente áreas que bordean el Estrecho de Magallanes, fueron también importantes con más de 15.3% del total regional. Otra área particularmente importante, fueron las lagunas en Rio Grande do Sul, estado en el sur de Brasil, especialmente Lagoa do Peixe; estas fueron las más importantes áreas, fuera de Tierra del Fuego con 20.7% del total regional, y las lagunas costeras en Uruguay con más de 4.3%. Pequeñas cantidades fueron encontradas a lo largo de la costa atlántica de Argentina, siendo la más importante extensión de costa alrededor del Golfo San Jorge.

Muchas de estas aves ocurrieron en roquerios de refugio (*restingas*) a lo largo de la costa argentina, o áreas rocosas intermareales, áreas fangosas o en lagunas. Pocos hábitats tierra adentro fueron cubiertos en áreas costeras de la provincia de Buenos Aires, aunque estas son conocidas por tener invernando números substanciales de playeros de lomo blanco y de playeros de Baird *Calidris bairdii* (Myers y Myers 1979).

3.2.2. Playero blanco *Calidris alba*

Cerca a 112 000 playeros blanco fueron observados en la evaluación. Las más importantes áreas de invernada estuvieron claramente a lo largo de las playas de la costa del Pacífico (Mapa 3.2.), el cual contenía el 87.8% del total; con el Atlántico y costa norte conteniendo unicamente 8.3% y 3.9% del total respectivamente. Los playeros blanco fueron los playeros pequeños más numerosos a lo largo de las playas de la costa Pacífica, conteniendo 94%

Tabla 3.3b
Totales de las especies de aves de orilla marina neárticas en las regiones y eco-unidades a lo largo de la costa de América del Sur—Aves de orilla marina de tamaño medio

Región/Eco-unidad	Eco-unidad longitud (km)	Chorlo dorado	Chorlo ártico	Vuelve-piedras	Playero de las rompientes	Especies de pata amarilla	Playero de pecho rojo	Especies de becasina	Aves de orilla marina no identificadas de tamaño medio	Total de aves de orilla marina de tamaño medio
Costa Norte										
Colombia - Caribe	853.7	0	1 241	175	0	19	0	1 558	3 020	6 014
Venezuela - Caribe Occidental	1 113.2	0	212	219	0	1 290	520	0	7 964	10 205
Venezuela - Caribe Central	275.6	0	48	0	0	779	0	7 113	300	8 240
Venezuela - Orinoco	549.2	0	143	42	0	308	0	3 100	10 435	14 028
Trinidad	483.8	0	173	6	0	518	0	209	80	986
Guyana	478.5	0	598	48	0	6 824	0	2 900	1 248	11 618
Surinam	369.8	0	3 940	619	0	66 377	0	21 840	55 392	148 168
Guyana Francesa	388.2	0	640	601	0	5 117	0	2 400	24 148	32 906
Brasil - Norte	464.3	47	676	191	0	205	120	20	1 064	2 323
Brasil - Amazonas	633.8	0	101	4	0	227	0	150	139	621
Brasil - Norte-Centro	2 504.7	0	14 711	17 909	0	798	8 191	8 105	47 508	97 227
Brasil - Noreste	1 248.4	82	1 289	433	0	218	15	35	688	2 760
Total regional (Costa Norte)	9 363.2	129	23 772	20 247	0	82 686	8 846	47 430	151 986	335 096
Costa del Atlántico										
Brasil - Este	939.0	0	168	321	0	59	0	0	131	679
Brasil - Río	394.9	0	76	1	0	4 808	0	0	0	4 885
Brasil - São Paulo	784.5	0	0	0	0	0	0	0	1	1
Brasil - Río Grande do Sul	882.9	629	3	0	0	419	0	0	711	1 762
Uruguay	621.9	3 167	365	253	0	88	0	0	3 087	6 960
Argentina - Buenos Aires	921.8	85	0	0	0	642	0	0	1 267	1 994
Argentina - Río Colorado	910.5	30	5	0	0	1	50	0	1 760	1 846
Argentina - Península Valdés	784.9	0	5	0	0	55	5 023	0	3	5 086
Argentina - Golfo San Jorge	730.9	0	0	320	0	17	8 691	0	100	9 128
Argentina - Río Gallegos	770.9	0	0	0	0	0	550	0	0	550
Argentina - Tierra del Fuego	430.0	0	0	1	0	0	10 470	0	1 120	11 591
Chile - Tierra del Fuego	619.2	0	0	2	0	14	42 762	0	428	43 206
Total regional (Costa del Atlántico)	8 791.4	3 911	622	898	0	6 103	67 546	0	8 608	87 688
Costa del Pacífico										
Chile - Chiloé	1 432.0	0	0	0	20	164	0	0	605	789
Chile - Concepción	880.7	0	0	0	0	36	0	0	15	51
Chile - Valparaíso	543.0	0	2	0	20	10	0	0	55	87
Chile - La Serena	846.2	14	4	29	61	0	0	0	0	108
Chile - Antofagasta	582.8	0	0	113	15	0	0	0	0	128
Chile - Arica	583.6	1	22	6	4	0	0	0	30	63
Perú - Mollendo	683.9	0	587	156	45	918	0	0	4 644	6 393
Perú - Lima	792.7	0	440	582	0	497	0	0	756	2 335
Perú - Chimbote	426.1	0	114	259	30	30	0	0	2	435
Perú - Chiclayo	871.6	0	203	911	2	454	0	0	12 633	14 204
Ecuador	1 385.5	0	1 082	109	0	135	0	825	1 334	3 485
Colombia - Pacífico	746.9	0	419	189	0	20	0	604	4 992	6 224
Total regional (Costa del Atlántico)	9 775.0	15	2 873	2 354	197	2 368	0	1 429	25 066	34 302
Total	27 929.6	4 055	27 267	23 499	197	91 047	76 392	48 859	185 660	457 086

a 100% de aves en esta categoría, en las eco-unidades entre Chiloé en el Sur de Chile y la costa norte de Perú.

Entre Perú (68.1%) y Chile (30.8%) contienen el 98.9% de playeros blancos que invernan en la costa pacífica. Las áreas más importantes ocurren en el norte del Perú, particularmente en Chiclayo, donde cerca a 32 000 (32.2% del total de la costa Pacífica) aves fueron contadas. En la línea costera se incluyen áreas importantes especialmente cerca a Pacasmayo, donde más de 11 000 fueron halladas, así como en la enorme playa frente al desierto de Sechura. Las playas en el centro y sur del Perú también contienen grandes cantidades, con 19.1% y 14.5% del total de la costa pacífica, respectivamente. De moderadas a grandes concentraciones ocurrieron a lo largo de las playas del centro y sur de Chile y el área de Chiloé con 10.4% del total de la costa pacífica y más de 2 500 aves se encontraron cerca a Coulin en la costa norte de la isla Chiloé.

De moderadas a pequeñas cantidades de playeros blanco ocurrieron en la mitad sur de la costa atlántica de América del Sur. Las playas de Rio Grande do Sul, Brasil, contienen el 70.5% del total regional de 9 300; playas adyacentes a las lagunas costeras, especialmente Lagoa do Peixe, fueron usadas más intensamente.

Pocos playeros fueron identificados en la costa norte de América del Sur. El total regional de 4 400 sólo representa el 3.9% del total de América del Sur. La mayoría de estas aves (71.3%) fueron encontradas fuera de las cabeceras arenosas altas de la costa norte central de Brasil, especialmente cerca a São Luís.

Tanto las densidades como las números de aves fueron más altos en las costas del Pacífico que del Atlántico (ver también Morrison 1984, Myers *et al.* 1985). Las mas altas densidades registradas fueron de 1 095 aves per kilómetro, envolviendo grandes bandadas en dormideros (7 700 aves) en un corto sector de evaluación (7.03 km), en la desembocadura del río Pisco en Perú. Las mas altas densidades en cada lugar, ocurrieron al norte del Perú a lo largo de la línea costera adyacente al desierto de Sechura.

Tabla 3.3*c*
Totales de las especies de las aves de orilla marina neárticas en las regiones y en las eco-unidades a lo largo de la costa de América del Sur—Aves de orilla marina de tamaño grande

Región/Eco-unidad	Eco-un. longitud (km)	Zarapito trinador	Playero de ala blanca	Aguja de mar	Aves de orilla marina no identificadas de tamaño grande	Total de aves de orilla marina de tamaño grande
Costa Norte						
Colombia - Caribe	853.7	29	21	0	0	50
Venezuela - Caribe Occidental	1 113.2	114	121	0	171	406
Venezuela - Caribe Central	275.6	5	464	0	50	519
Venezuela - Orinoco	549.2	207	273	0	0	480
Trinidad	483.8	75	184	0	0	259
Guyana	478.5	57	283	0	0	340
Surinam	369.8	3 310	15 646	0	2 580	21 536
Guyana Francesa	388.2	326	729	0	1 039	2 094
Brasil - Norte	464.3	138	25	0	511	674
Brasil - Amazonas	633.8	0	0	0	2	7
Brasil - Norte-Centro	2 504.7	10 879	21 868	4	1 382	34 133
Brasil - Noreste	1 248.3	117	26	0	40	183
Total regional (Costa Norte)	9 363.2	15 257	39 640	4	5 775	60 681
Costa del Atlántico						
Brasil - Este	939.0	66	77	0	0	143
Brasil - Río	394.9	0	0	0	0	0
Brasil - São Paulo	784.5	0	0	0	0	0
Brasil - Río Grande do Sul	882.9	3	0	0	4	7
Uruguay	621.9	2	0	326	94	422
Argentina - Buenos Aires	921.8	6	0	429	47	482
Argentina - Río Colorado	910.5	0	0	313	5	318
Argentina - Península Valdés	784.9	0	0	0	0	0
Argentina - Golfo San Jorge	730.9	0	0	352	5	357
Argentina - Río Gallegos	770.9	0	0	160	3	163
Argentina - Tierra del Fuego	430.0	14	0	19 472	0	19 486
Chile - Tierra del Fuego	619.2	119	0	11 660	0	11 779
Total regional (Costa del Atlántico)	8 791.4	210	77	32 712	158	33 157
Costa del Pacífico						
Chile - Chiloé	1 432.0	6 210	0	12 642	4	18 856
Chile - Concepción	880.7	617	0	0	0	617
Chile - Valparaíso	543.0	384	0	0	0	384
Chile - La Serena	846.2	291	0	0	0	291
Chile - Antofagasta	582.8	31	2	0	0	33
Chile - Arica	583.6	59	0	0	0	59
Perú - Mollendo	683.9	79	1	1	0	81
Perú - Lima	792.7	620	156	170	42	988
Perú - Chimbote	426.1	65	0	0	0	65
Perú - Chiclayo	871.6	169	431	0	500	1 100
Ecuador	1 385.5	562	3 384	0	60	4 006
Colombia - Pacífico	746.9	320	679	0	0	999
Total regional (Costa del Pacífico)	9 775.0	9 407	4 653	12 813	606	27 479
Total	27 929.6	24 874	44 370	45 529	6 539	121 317

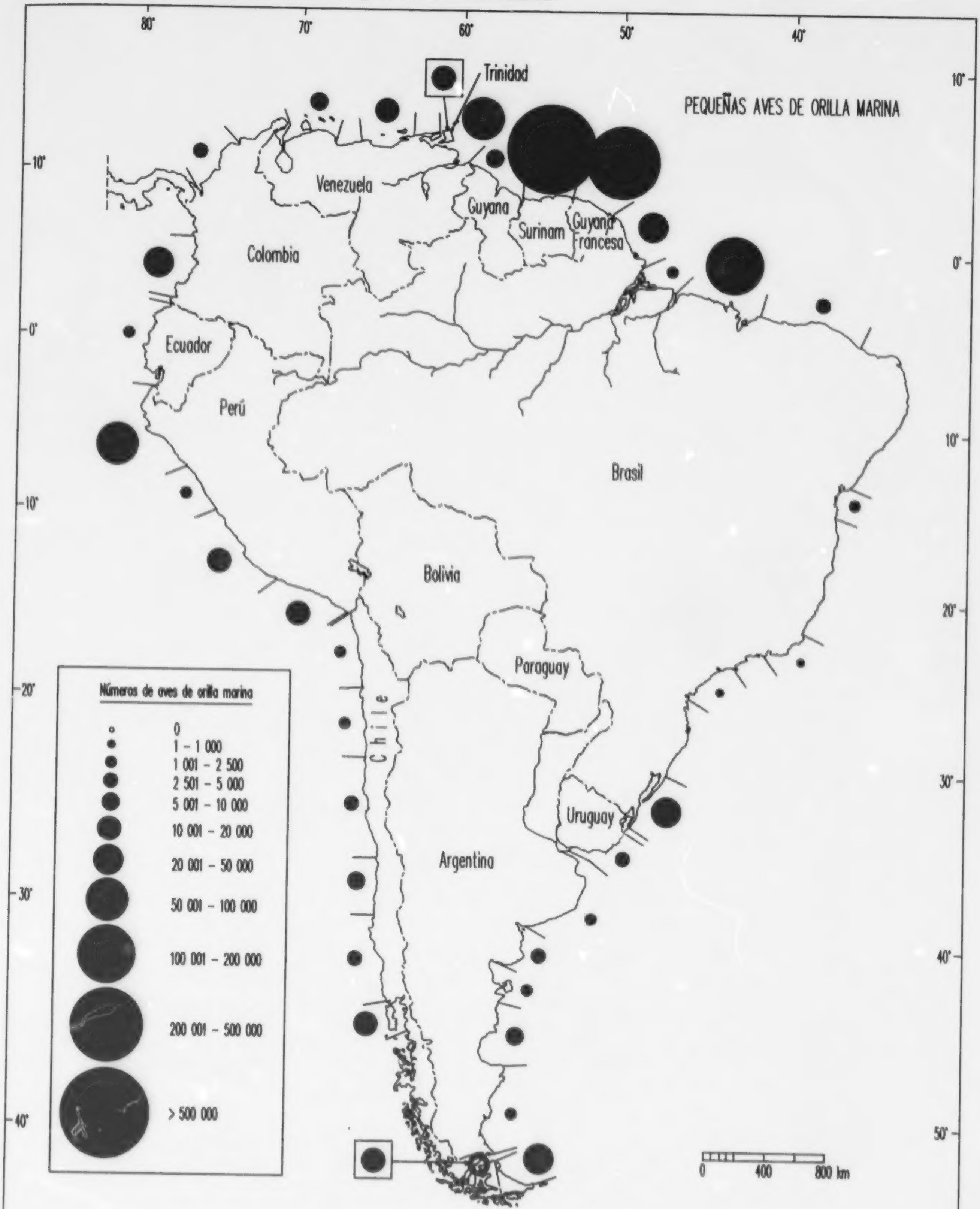
Las densidades alcanzaron a 278 aves per kilómetro en los alrededores de Pacasmayo y 186 aves per kilómetro cerca al extremo nor-oeste de las playas del desierto de Sechura: la densidad promedio en esta área fue en general de 117 aves per kilómetro. Las densidades también fueron altas en el sur del Perú cerca al límite con Chile, alcanzando 242 aves per kilómetro cerca a Tacna. En lugares de Perú y Chile, generalmente las densidades oscilaron desde 25 a 60 aves per kilómetro. Sobre la costa atlántica, las densidades más altas fueron registradas en Rio Grande do Sul en el sur de Brasil, en la costa cerca a Lagoa do Peixe (69 aves per kilómetro); y en la costa norte cerca a São Luís, esta fue de 25 aves per kilómetro.

Estudios de marcado de colores realizados por Myers *et al.* (1984), han mostrado que muchos de los playeros que invernan en la costa pacífica, migran hacía el norte a las tierras de reproducción, via la costa oeste de Norte América, o centralmente por la costa del Golfo de México en Texas y a través de Prairies, y la migración hacía el sur via la costa oeste de Norte América o el interior. Muchas aves realizan una migración eliptica en sentido de las agujas del reloj. La mayoría de las aves migran en primavera hacía el norte, a lo largo de la costa atlántica de los Estados Unidos de Norte América, a través de grandes áreas de descanso tales como Delaware Bay y aunque no todas vienen de las tierras de invernada de la costa pacífica en América del Sur, más consistentes poblaciones invernantes, provienen del lado atlantico de América del Sur.

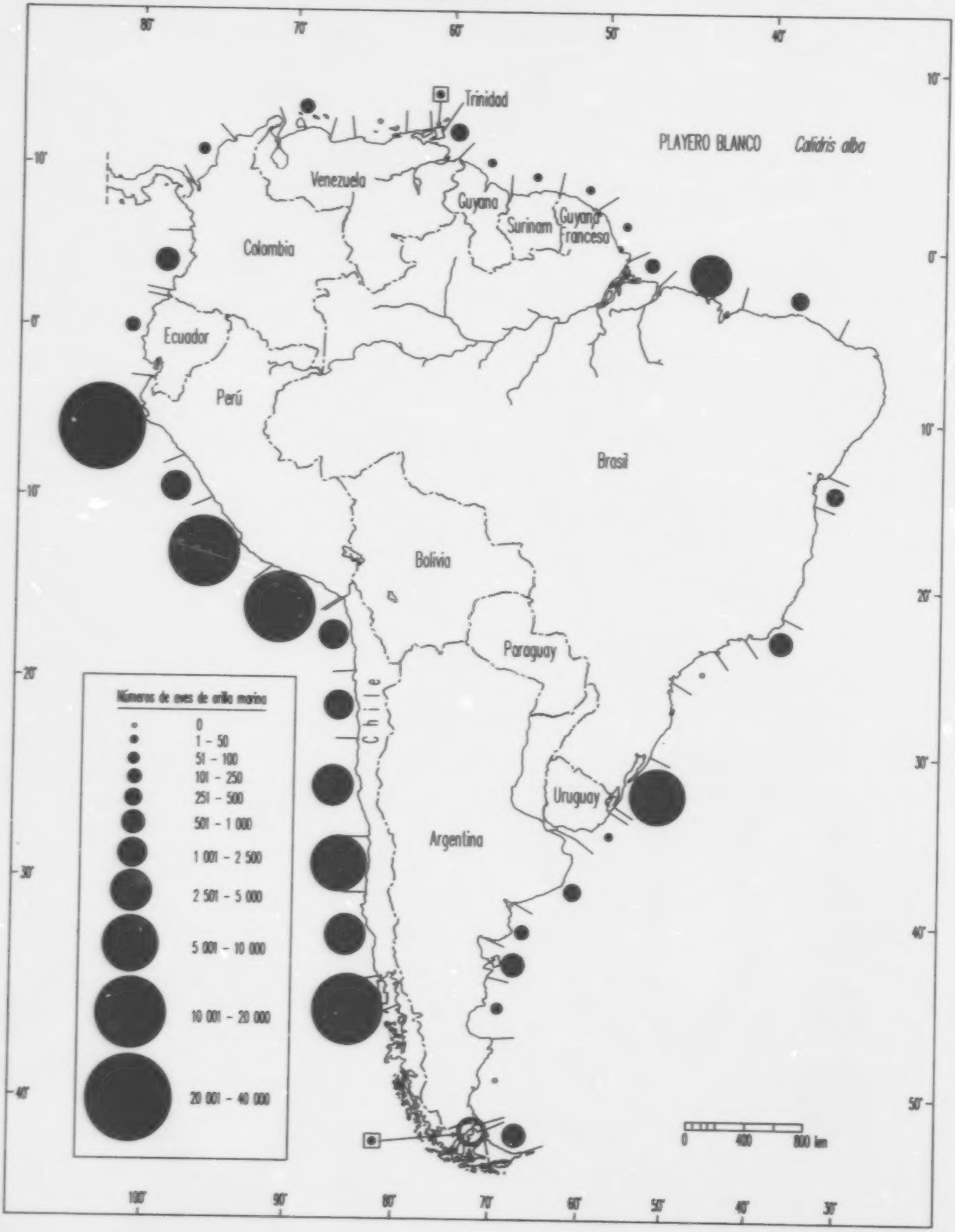
3.2.3. Aves de orilla marina de tamaño medio

Apróximadamente 457 000 aves de orilla marina de tamaño medio, fueron contadas en la evaluación (Tabla 3.2.). En algunos centros de distribución ocurrieron, diferentes especies que predominaron en diferentes regiones (Mapa 3.3., Tabla 3.3.*b*). La costa norte del continente fue particularmente importante, especialmente para el chorlo artico *Pluvialis squatarola*, vuelvepiedras *Arenaria interpres*, pata amarilla *Tringa* spp. y la becasina *Limnodromus* spp. Las Guyanas contenian el 42.1% del total de aves de orilla marina de tamaño medio para América del Sur (Surinam 32.4%, Guyana Francesa 7.2%, Guyana 2.5%), la parte nor-central de Brasil también tuvo cantidades muy

Mapa 3.1
Distribución de las pequeñas aves de orilla marina a lo largo de la costa de América del Sur

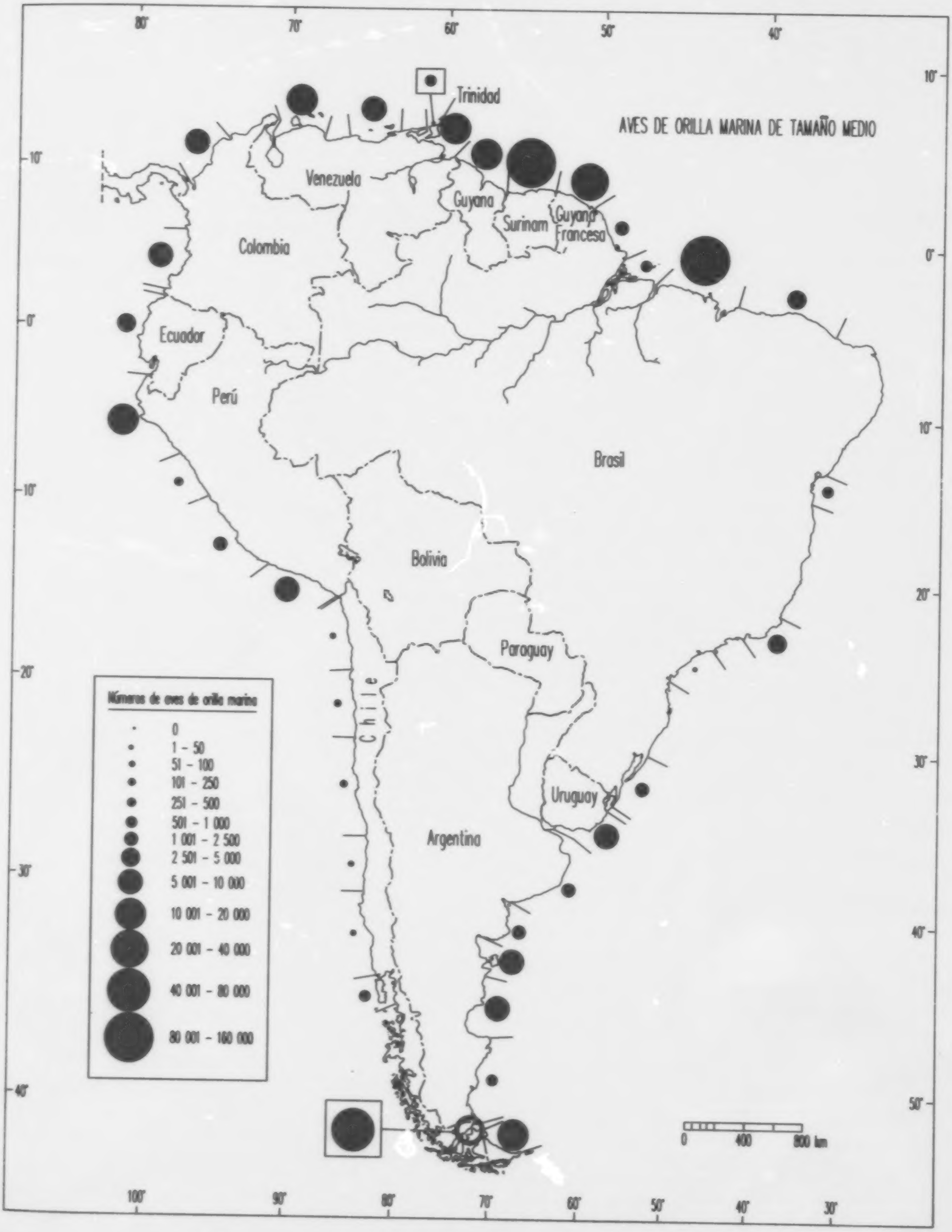

PEQUEÑAS AVES DE ORILLA MARINA
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 50 000
50 001 - 100 000
100 001 - 200 000
200 001 - 500 000
> 500 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Mapa 3.2
Distribución del playero blanco (*Calidris alba*) a lo largo de la costa de América del Sur



PLAYERO BLANCO *Calidris alba*
Trinidad
Venezuela
Colombia
Guyana
Surinam
Guyana Francesa
Ecuador
Perú
Brasil
Bolívia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.3
Distribución de aves de orilla marina de tamaño medio a lo largo de la costa de América del Sur


AVES DE ORILLA MARINA DE TAMAÑO MEDIO
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
80 001 - 160 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

significativas (21.3%). Los altos números de aves de orilla marina de tamaño medio, invernando en Argentina y Chile (6.6% y 9.7%, respectivamente) fueron del playero de pecho rojo *Calidris canutus*, a lo largo de la línea costera de Tierra del Fuego y la Patagonia. Relativamente pocas aves de orilla marina de tamaño medio fueron encontradas a lo largo de la costa pacífica de Chile y Perú: el chorlo ártico y el vuelvepiedras estuvieron entre las especies más comunes en esta categoría de tamaño, en las playas, los patas amarilla y chorlos ártico, así como una variedad de otras especies ocurrieron en pantanos costeros. Moderados números de aves de orilla marina de tamaño medio ocurrieron en las ciénagas a lo largo de la línea costera de Ecuador y Colombia.

3.2.4. Chorlo ártico *Pluvialis squatarola*

En promedio el chorlo ártico fue encontrado a lo largo de la línea costera tropical de la mitad hacía el norte de América del Sur, particularmente a lo largo de la costa norte (Mapa 3.4.). Del total de 27 300 contados en la evaluación, 87.2% estuvieron en la costa norte del continente, conteniendo la costa pacífica 10.5% y la costa atlántica 2.3%.

La costa nor-central de Brasil, entre Belém y São Luís fue la más importante área de invernada, con 14 700 aves, 61.9% del total de la costa norte o 54% del total de América del Sur. Esta forma muy irregular de la línea costera conteniendo bahías y peninsulas con extensas ciénagas, pantanos, manglares y playas provee abundantes hábitats de forrajes y dormideros para estas especies. La línea costera es larga: cerca a 2 500 km fueron evaluados. En casi todas las eco-unidades la densidad fue de 6 aves per kilómetro, con densidades en sectores individuales arriba de las 26 aves per kilómetro. Surinam fue la siguiente área más importante, con 16.6% del total regional (14.5% del total de América del Sur). La costa de Surinam es considerablemente estrecha, consistente en muy extensas tierras fangosas alternando con trechos de playa/bancos de fango: la densidad en estas eco-unidades fue de 10.7 aves per kilómetro, con densidades en sectores individuales arriba de las 49 aves per kilómetro; mas sectores con densidades que no excedieron las 20 aves per kilómetro.

Otras áreas significativas incluyeron partes de la costa caribeña de Colombia (1 200 aves, 5.2% o 4.6% del total de la costa norte y de América del Sur, respectivamente) y la costa nor-este de Brasil (1 300 aves, 5.4% y 4.7% como arriba). En Colombia, la mayoría de las aves fueron encontradas en lagunas superficiales, en áreas adyacentes a la línea de marea, especialmente aquellas cerca a la boca del río Magdalena en Barranquilla. En el nor-este de Brasil, las aves fueron encontradas a lo largo de las playas con orillas rocosas, particularmente entre São Luís y Parnaíba.

En el lado del Pacífico, las especies fueron halladas principalmente en Perú, Ecuador y Colombia con individuos dispersos encontrados desde el sur de Chile hasta el límite Peru/Chile. Los registros (dos aves) mas hacía el sur de la evaluación fueron efectuados cerca al río Mataquito en la eco-unidad de Valparaiso. En Perú, donde solo 1 300 aves fueron contadas (46.8% del total de la costa pacífica, 4.9% del total de América del Sur), muchos chorlos ártico fueron encontrados separadamente en humedales ubicados a lo largo de la costa. En la parte sur del país, las especies ocurrieron en los humedales costeros cerca a la desembocadura del río Camaná (235), el río Locumba (120) y las lagunas de Mejía. Otras observaciones en el norte y centro del Perú, involucraron aves en los humedales costeros o a lo largo de las playas de esos humedales (por ejemplo río Huaura, Paramonga, Bahía de Sechura). Uno de los grupos mas grandes fue de 260 aves en la Bahía de Paracas, dentro de la Reserva Nacional.

En el Ecuador, chorlos ártico fueron observados principalmente alrededor de la línea costera del Golfo de Guayaquil. Muchos de ellos se encontraron, fuera de la línea costera del Golfo, donde existe una mezcla de hábitats fangosas intermareales y arenosas que en relación a las zonas interiores fangosas, y parte de manglares. Hábitats favorables fueron hallados en el norte del límite del Perú, en la esquina sur-este de la isla Puna y el nor-oeste en la entrada de la bahía. Las especies fueron más comunes en hábitats similares en el sur de Colombia entre Tumaco y Buenaventura.

Pocos chorlos ártico (620, 2.3% del total de América del Sur), fueron observados en la evaluación de la costa atlántica. Muy pocos fueron vistos en el sur de Uruguay y Argentina—unos pocos en el estuario cerca a Bahía Blanca sobre las costas cercanas al estuario San Antonio Oeste. Las mas grandes concentraciones se encontraron en Laguna da Rocha, una extensa laguna salubre adyacente a la línea costera uruguaya. Pequeños números fueron hallados a lo largo de la línea de playa en el norte de Rio de Janeiro, donde pequeñas charcas y lagunas están situadas detrás de la playa y en la Bahía de Todos los Santos cerca a Salvador. Las especies también fueron observadas en pequeños números en los fangales, manglares y estuarios en el sur de Salvador cerca a Valenca y Itubera.

3.2.5. Vuelvepiedras *Arenaria interpres*

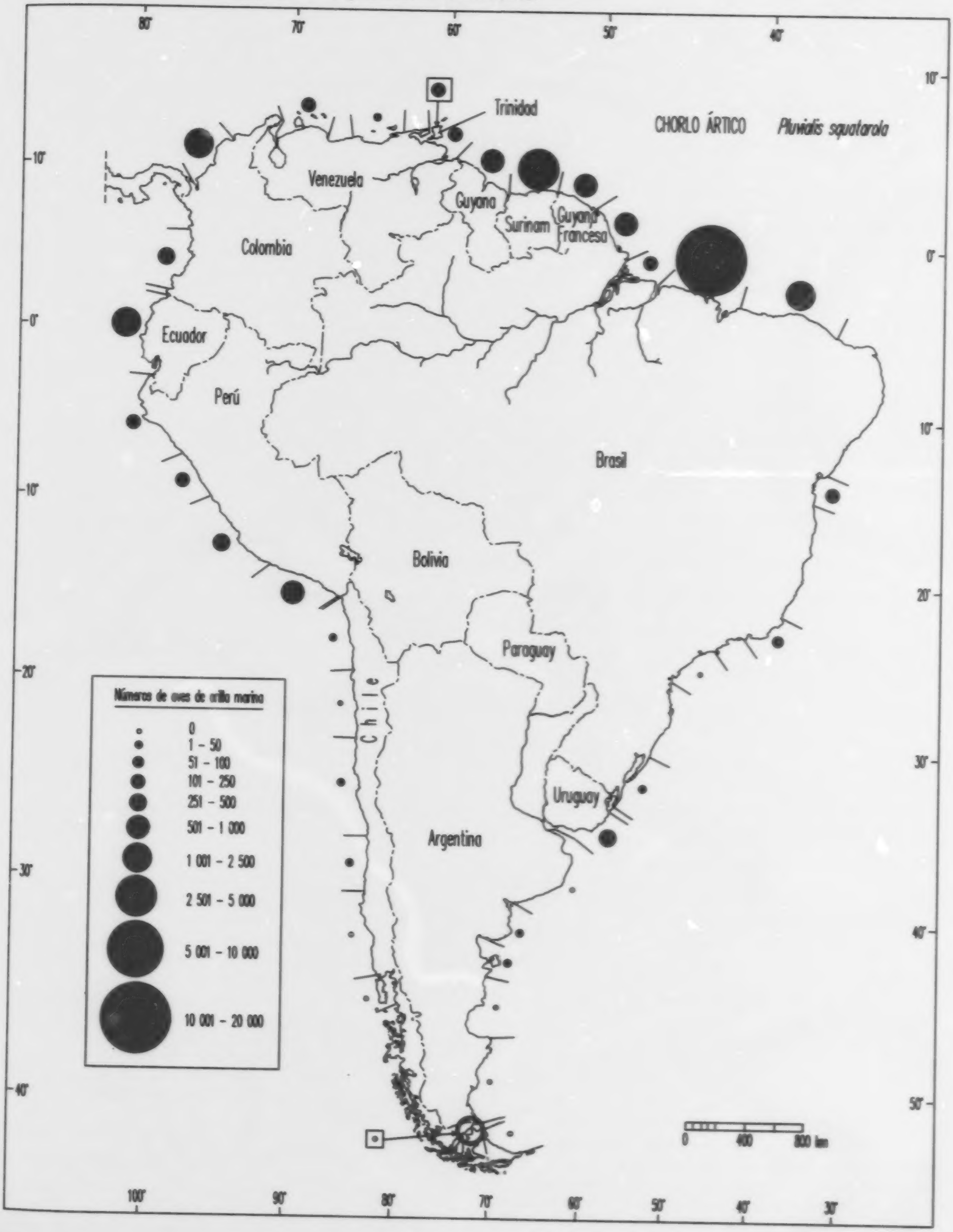
El vuelvepiedras está ampliamente distribuido en América del Sur, habiendo sido observado en pequeños números al Sur en Tierra del Fuego. Ellos fueron más númerosos en la costa norte del continente y poco común en las playas de la costa pacífica (Mapa 3.5.). Del total de 23 500 contados en la evaluación, 86.2% ocurrieron en la costa norte, con 10% en la costa pacífica y solo 3.8% en la costa atlántica.

Pero el área más importante para el vuelvepiedras fue la costa nor-central de Brasil entre Belém y São Luís, donde más de 17 900 aves fueron contadas, representando el 76.2% del total de América del Sur (88.5% del total de la costa norte). Esta larga línea costera contiene una abundancia de densos bancos de fango preferidos por los vuelvepiedras. Otras áreas importantes incluyeron Surinam (2.6% y 3.1% del total de la costa norte y de América del Sur, respectivamente), y Guyana Francesa (2.6%, 3.0% como arriba), así como también la costa nor-este de Brasil en playas con orilla rocosa.

Sobre la costa pacífica, más de 2 400 aves registradas fueron halladas en Perú (81.1% del total de la costa pacífica, o 8.1% del total de América del Sur). Las aves fueron más numerosas en sectores que contienen playas de arena o con cascajo, con entradas de río, pozas, humedales o terrenos de cultivo adyacentes a la playa. En Ecuador y Colombia, los vuelvepiedras usualmente se encontraron en las costas con playas de arena cerca a entradas o grandes áreas intermareales horizontales.

Las densidades de los vuelvepiedras fueron también generalmente altas, en la costa nor-central de Brasil, con un número de sectores que presentan densidades en un rango entre 10–20 aves per kilómetro sobre distancias de 60–124 km, con valores altos de 31 aves per kilómetro. Las densidades en las Guyanas, la siguiente área más impor-

Mapa 3.4
Distribución de chorlos ártico (*Pluvialis squatarola*) a lo largo de la costa de América del Sur


CHORLO ÁRTICO *Pluvialis squatarola*
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

tante, fueron generalmente bajas, no excediendo frecuentemente de una ave per kilómetro, con altos valores registrados de nueve aves per kilómetro en Surinam y 13 aves per kilómetro en Guyana Francesa. Las densidades fueron también bajas en la costa pacífica: en el Perú, raramente excedieron de una ave per kilómetro, con altos valores registrados de 12 aves per kilómetro a lo largo de las playas cerca al desierto de Sechura en el norte del Perú.

3.2.6. Pata amarilla *Tringa* spp.

Los patas amarilla se encuentran ampliamente distribuidos en América del Sur (Mapa 3.6.), aunque ellos están mas claramente concentrados en la costa norte del continente, donde las mayores áreas de invernada están ubicadas en las Guyanas. Aunque no estamos muy seguros de haber identificado, desde el aire separadamente las dos especies: pata amarilla mayor *T. melanoleuca* y pata amarilla menor *T. flavipes*, el total para las dos especies fue uno solo. Más de 91 000 patas amarilla fueron observados en la evaluación — 90.7% en la costa norte, 6.7% en la costa atlántica y 2.6% en el lado pacífico del continente.

Las mayores áreas costeras de invernada para pata amarilla estuvieron claramente en las Guyanas. Entre estos, los tres países tuvieron 78 000 aves, representando el 85.9% del total para América del Sur. Surinam fue individualmente la más importante región, con 72.8% del total de América del Sur, Guyana contenia 7.5% y Guyana Francesa 5.6%. Los patas amarilla fueron particularmente comunes en áreas con extensos fangales intermareales, o en lagunas abiertas adyacentes, hábitats muy abundantes en las Guyanas, especialmente en Surinam. Hábitats similares en el este de Guyana y oeste de Guyana Francesa fueron usados intensamente. En cada lugar de la costa norte, los patas amarilla ocurrieron más en hábitats de lagunas adyacentes a la playa, tal como las lagunas Campuchano en el occidente de Venezuela, la laguna Piritu y laguna oeste de Barcelona en Venezuela central y el pantano Caroni en Trinidad.

Sobre la costa atlántica, las mas grandes cantidades ocurrieron en la superficie, en áreas húmedas detrás de la costa entre el cabo de São Tomé y este de Atafona del lago de Feia en la eco-unidad Río en Brasil. Las líneas de playa de las lagunas no lejanas a la costa, también fueron usadas en el sur de Brasil, incluyendo las líneas costeras de Lagoa dos Patos y pequeñas lagunas cercanas en Uruguay (Laguna de Rocha) y sobre la costa de la Provincia de Buenos Aires en Argentina (Laguna Mar Chiquita y Laguna Salada). Sin embargo en Argentina las mayores concentraciones estuvieron en la costa pantanosa de la Bahía Samborombon.

En el lado pacífico las lagunas costeras, pantanos o humedales asociados con ríos, fueron también nuevamente los hábitats más importantes. En el Perú por ejemplo, grandes cantidades fueron encontradas en los humedales del Río Camaná (900), las lagunas norte de Eten (450), humedales y boca del río Pisco (340). Relativamente grandes cantidades ocurrieron en áreas fangosas de la Reserva de Paracas.

3.2.7. Playero de pecho rojo *Calidris canutus*

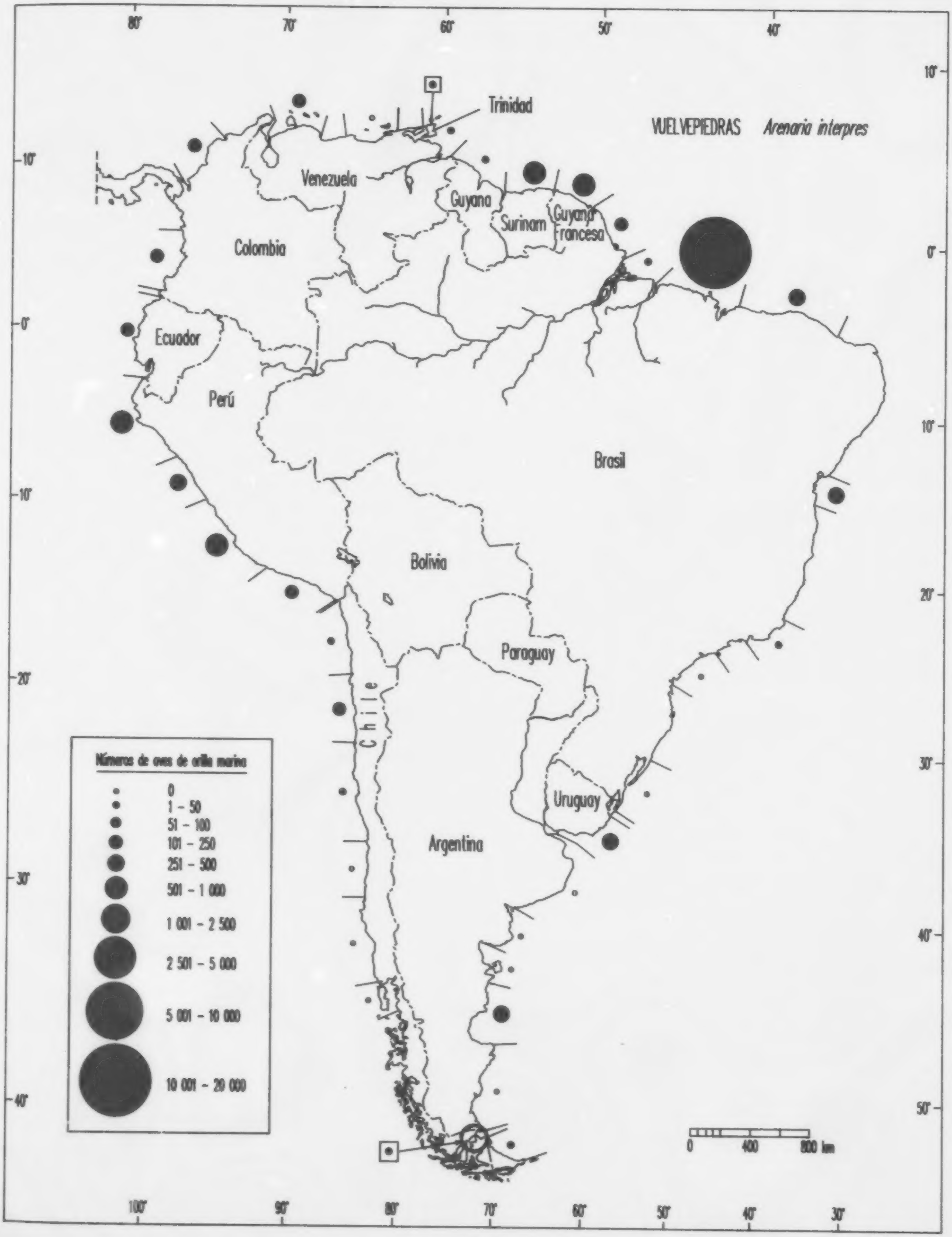
Las mayores tierras de invernada del playero de pecho rojo estuvieron en Tierra del Fuego, a lo largo de la línea costera de la Patagonia en Argentina (Mapa 3.7.). Pocas concentraciones grandes fueron vistas en cada lugar; pequeñas cantidades ocurrieron en la parte nor-central de Brasil y al oeste de Venezuela y desde allí fueron raras las observaciones en cada lugar a lo largo de la costa norte de Brasil.

De lejos el sitio descubierto más importante fue Bahía Lomas, situado cerca de la boca este del estrecho de Magallanes en la costa norte del sector chileno en Tierra del Fuego. La bahía contiene una amplia área de llanuras barrosas continuas y canalizadas, detrás de las cuales existe una lluvia de gramadales y en toda esta zona en enero de 1985 se contaron 41 700 playeros de pecho rojo, o 54.6% del total de América del Sur. Otras concentraciones importantes envolvieron 5 100 aves cerca a Rio Grande y 4 400 en la vecindad de la Bahía de San Sebastián en la costa argentina de Tierra del Fuego. El playero de pecho rojo en Río Grande se alimentaba en extensas áreas rocosas expuestas a las mareas o en zonas cascajosas en Punta Popper o en la playa de Río Grande. Las aves en la Bahía de San Sebastián han hecho uso de fangales vastamente canalados en la bahía y en zonas cascajosas a lo largo de la costa. Aunque el sector chileno de Tierra del Fuego contiene cerca a 42 800 playeros de pecho rojo y el sector argentino, algo así como 10 500, representando el 56.0% y 13.7% respectivamente, y combinado alcanza el 69.7% del total de América del Sur.

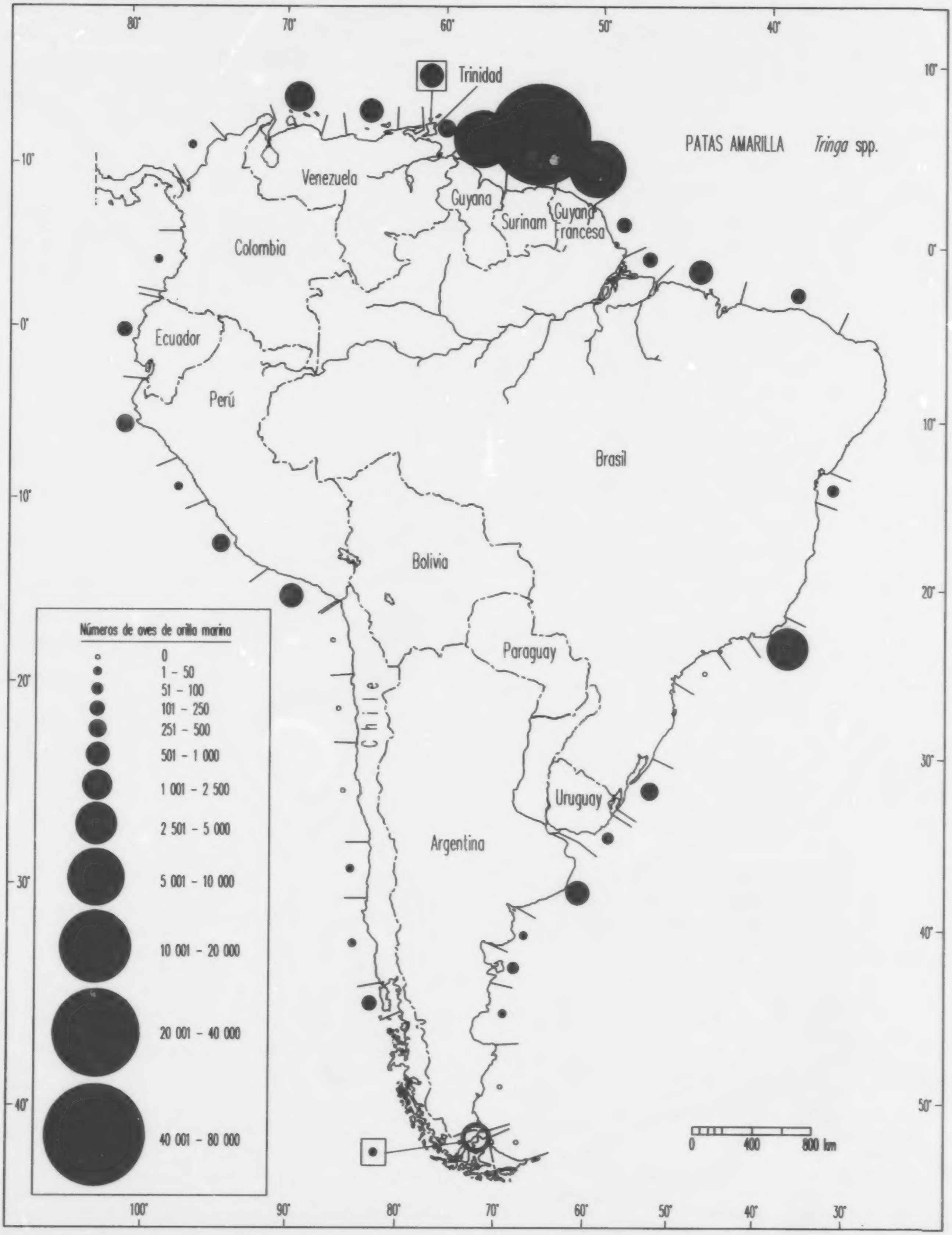
Otras significativas bandadas invernantes fueron halladas a lo largo de la orilla de la Patagonia Argentina alrededor del Golfo San Jorge y la Peninsula Valdés. En la eco-unidad del Golfo San Jorge se contó 8 700 playeros de pecho rojo (11.4% del total de América del Sur), con cantidades significativas en particular en el área de Bahía Bustamante (7 400) y a lo largo de partes altas al sur de Commodoro Rivadavia entre Caleta Olivia y Cabo Blanco (1 300). La eco-unidad de Peninsula Valdés, fue otro punto focal que contenía más de 5 000 playeros de pecho rojo (6.6% del total de América del Sur). Las bandadas fueron observadas en un número de localidades alrededor de la península, 1 200 al norte cerca a Puerto Lobos, sobre las orillas del Golfo San Matías, 1 000 cerca a Caleta Valdés, 2 000 cerca a Punta Delgada y 300 y 500 cerca a la entrada a Golfo Nuevo. El Golfo San José en el lado norte de la península es conocida como un importante lugar de descanso durante la migración hacía el norte (Harrington 1982; Morrison 1984); sin embargo no fue cubierto en la evaluación por razones logísticas. Pequeñas concentraciones de playeros de pecho rojo, fueron encontrados más al sur de la costa de la Patagonia, sur de Puerto Deseado cerca a Punta Medanosa (400) y Cabo Danaso (150). Todos los 67 500 playeros de pecho rojo invernantes en la costa atlántica fueron hallados entre Tierra del Fuego y el río Colorado en Argentina y representó el 88.4% del total de las especies para América del Sur.

El 11.6% remanente fue observado en la costa norte del continente. Muchos de ellos ocurrieron en la costa norcentral de Brasil, en donde 8 200 aves fueron identificados como playeros de pecho rojo (10.7% del total de América del Sur), ocurrieron principalmente en dos bandadas de 5 000 y 3 000 respectivamente, en el área de São Luís. Esta en una región muy productiva y la línea costera de marcada forma irregular, proporcionó una amplia variedad de hábitats arenosos y fangosos y para alimentación y como dormideros y es importante para un rango de especies, particularmente entre las medianas y las más grandes. La otra notable concentración (520) fue observada en el oeste de Venezuela en la boca del lago Maracaibo cerca a las orillas del golfo de Venezuela.

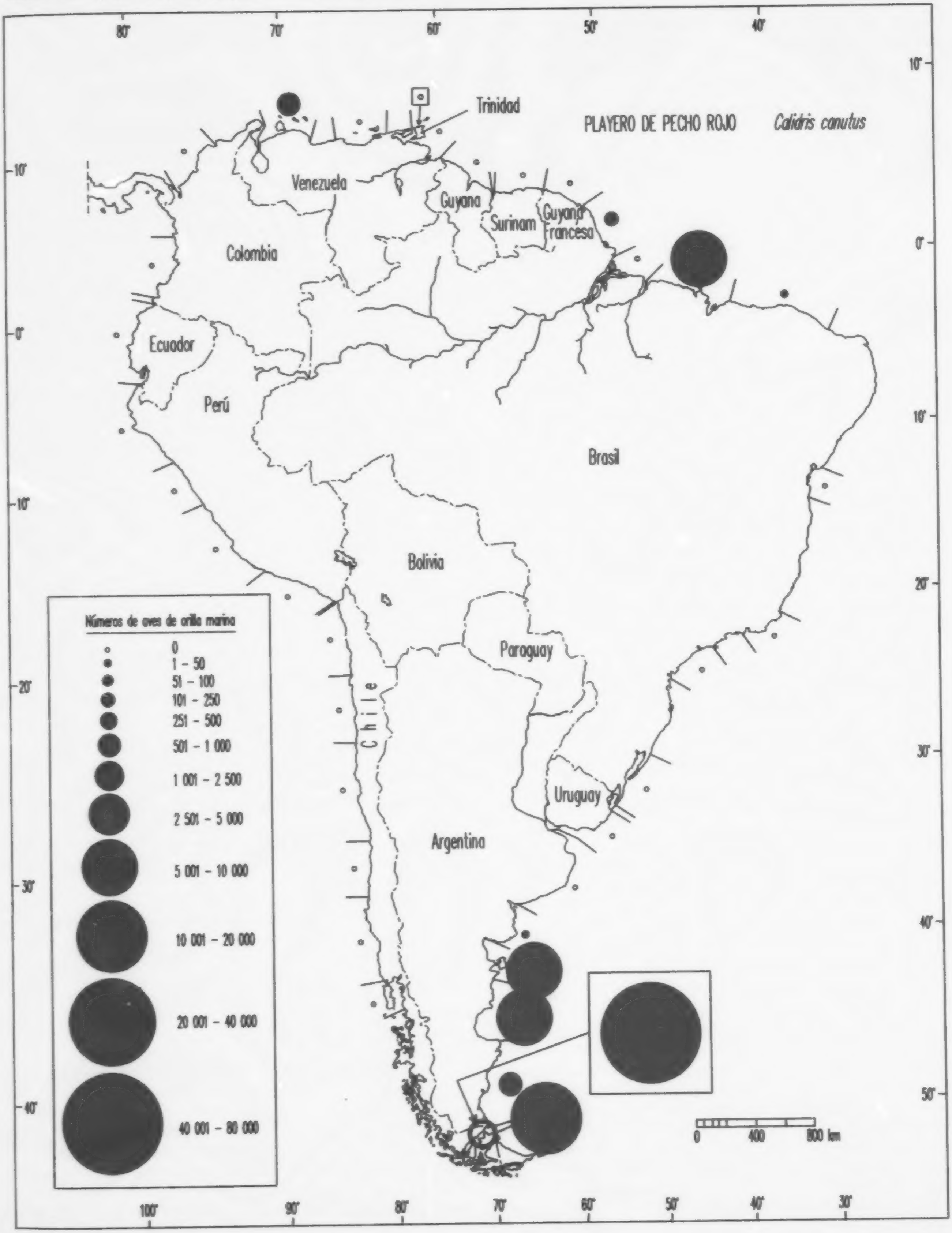
Mapa 3.5
Distribución de vuelvepiedras (*Arenaria interpres*) a lo largo de la costa de América del Sur


VUELVEPIEDRAS *Arenaria interpres*
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0 400 800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.6
Distribución de patas amarilla (*Tringa* spp.) a lo largo de la costa de América del Sur


PATAS AMARILLA *Tringa* spp.
Trinidad
Venezuela
Colombia
Guyana
Surinam
Guyana Francesa
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.7
Distribución de playeros de pecho rojo (*Calidris canutus*) a lo largo de la costa de América del Sur


PLAYERO DE PECHO ROJO
Calidris canutus
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Ningún ejemplar de playeros de pecho rojo fue identificado durante la evaluación aérea sobre las costas de América del Sur, aunque pequeñas cantidades hansido observadas en evaluaciones terrestres sobre la costa (resultados publicados; por ejemplo Hughes 1976).

3.2.8. Becasina *Limnodromus* spp.

Aunque desde el aire no fue posible distinguir las dos especies de becasina, muy pocas, de las becasinas pico largo *L. scolopaceus*, llegan a América del Sur (Blake 1977), de tal manera que todas las observaciones efectuadas en las evaluaciones sobre becasina, serían de la becasina pico corto *L. griseus*.

Las becasinas estuvieron claramente restringidas a la parte norte del continente, especialmente la costa norte donde fueron observados el 97.1% de un total de 49 000 (Mapa 3.8.). El 2.9% remanente ocurrió en la costa pacífica, siendo el extremo sur el Ecuador. Nunca fue registrado mas hacía el sur de este lugar de la costa pacífica y tampoco fueron registradas en la costa atlántica.

Las becasinas fueron observadas principalmente en las costas de manglares con grandes variaciones de mares, o en lagunas costeras. Ellas estuvieron concentradas en tales hábitats en Surinam, donde ocurrieron el 44.7% del total de América del Sur. Hábitats similares en las vecinas Guyana (5.9%) y Guyana Francesa (4.9%) tambien tuvieron concentraciones significativas. La segunda región más importante en América del Sur, fue la costa nor-central de Brasil entre Belém y São Luís, donde 8 100 aves (16.6%) fueron halladas en los manglares y en zonas intermareales de líneas de costa fuertemente irregulares. Las lagunas de la costa central de Venezuela, tales como el este de Barcelona y especialmente la laguna Chacopata, tuvieron también cantidades substanciales (7 100, 14.6%). Un patrón similar fue observado en otras partes, con las especies halladas en las costas de los manglares en el delta del Orinoco (3 100, 6.3%), lagunas de la costa caribeña de Colombia (1 600, 3.2%) y costas de los manglares o entradas de la costa pacífica de Colombia (600, 1.2%) y en Ecuador (830, 1.7%).

3.2.9. Aves de orilla marina de tamaño grande

Más de 121 000 aves de orilla marina de tamaño grande, fueron contadas en la evaluación, conformando 4.2% del gran total de 2.9 millones de aves neárticos de orilla marina (Tabla 3.2.) Algunos centros de distribución fueron encontrados — en Suriname, sobre la costa nor-central de Brasil, en Tierra del Fuego y en el área de Chiloé — reflejando esta tendencia, distribución de diferentes especies (Mapa 3.9.).

3.2.10. Playero de ala blanca *Catoptrophorus semipalmatus*

Las mayores áreas de invernada para el playero de ala blanca en América del Sur estuvieron en la costa norte del continente, donde el 89.3% del total de 44 400 fueron observados (Mapa 3.10.). Los playeros de ala blanca estuvieron asociados con las líneas costeras de los manglares con extensas áreas intermareales, bancos y fangales. Tales hábitats fueron abundantes a lo largo de la línea costera altamente irregular de la parte nor-central de Brasil, la cual fue la más importante región para estas especies, teniendo apróximadamente (49.3%) la mitad del total de América del Sur. Surinam, el cual también contiene extensas áreas de tales hábitats, fue segundo en importancia, con 35.3% del total de América del Sur. Los playeros de ala blanca fueron más raros, a lo largo del resto de la costa norte en cantidades pequeñas, aunque ninguno fue hallado en la boca del río Amazonas (Tabla 3.3.).

La distribución de los manglares, efectivamente limitó la distribución de los playeros de ala blanca, en las costas pacífica y atlántica, aunque unas pocas aves se encontraron al sur en las costas de Perú y en el Norte de Chile. Sobre la costa pacífica de Colombia, los playeros de ala blanca fueron hallados en las entradas de los manglares (1.5%) particularmente entre la bahía de Buenaventura y el límite con el Ecuador. En Ecuador, más aves (3 400, 7.6%) fueron halladas en las costas de los manglares del golfo de Guayaquil (1 900) o en manglares con entradas complejas, tal como la bahía de Caraquez (1 200). Muchas de las aves registradas en el Perú (590, 1.3%) fueron halladas en el norte en los manglares (Tumbes, 22), complejos humedales (Sechura, 170) o estuarios (Virrilá, 200), aunque unos pocos fueron hallados en el sur a lo largo de la línea costera de las playas, frecuentemente donde los arroyos o humedales ocurrieron, tan al sur como al norte de Chile.

En la costa atlántica, los playeros de ala blanca, no fueron hallados al sur del área de Salvador, donde ellos ocurrieron en números pequeños (80, 0.2%) o en las entradas o sobre las líneas de playa (Bahía de Todos os Santos, Valenca, Itubera).

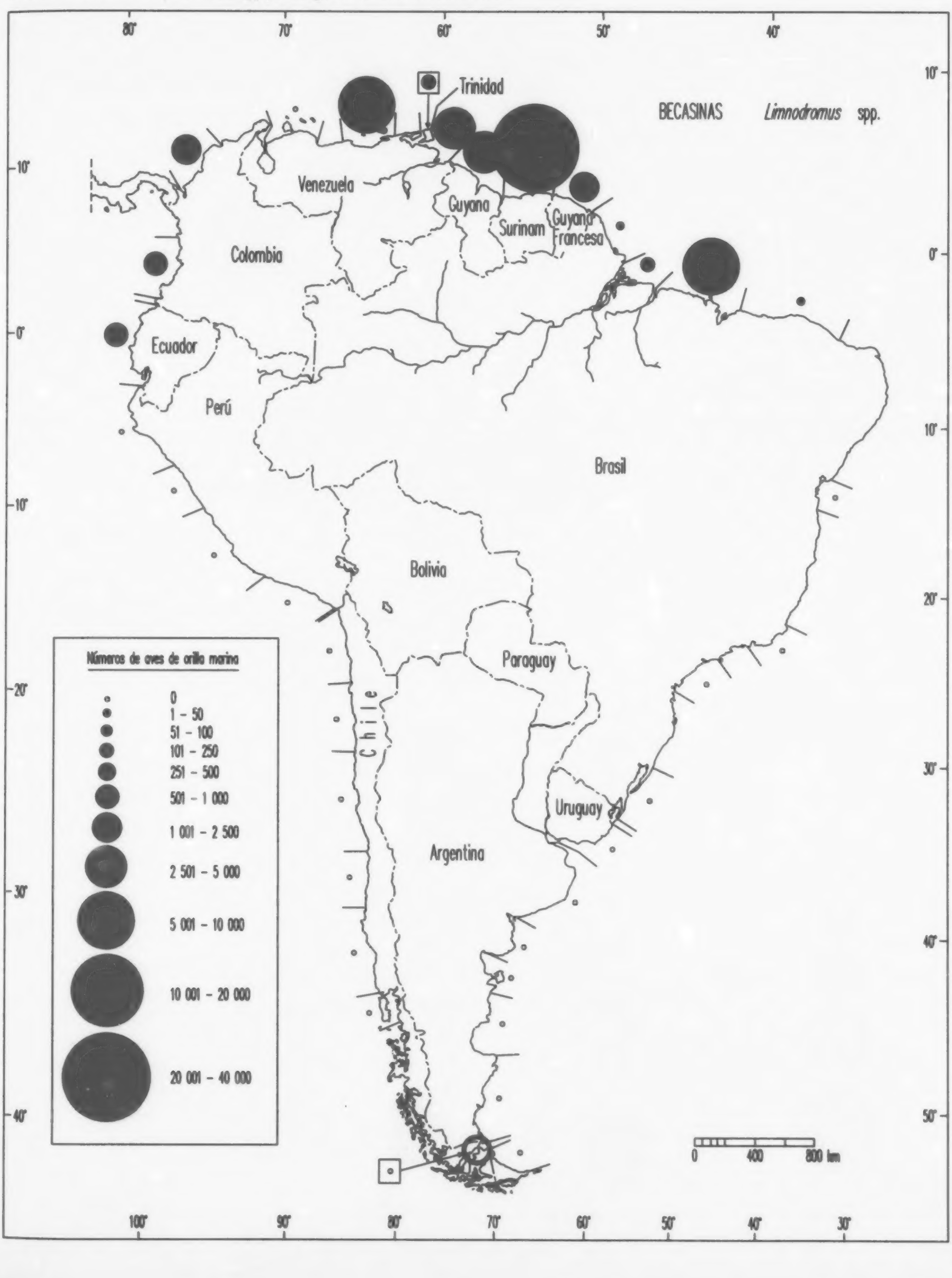
3.2.11. Aguja de mar *Limosa haemastica*

Las mayores áreas de invernada costeras de las agujas de mar, estuvieron situadas en el extremo sur del continente. Dos centros de distribución fueron evidentes; el más importante estuvo en Tierra del Fuego, con áreas alrededor de la isla de Chiloé en el sur de Chile, soportando también significativas concentraciones (Mapa 3.11.). Sobre el total de 45 000 aves contadas, 71.9% fueron halladas en la costa atlántica y 28.1% en la costa pacífica.

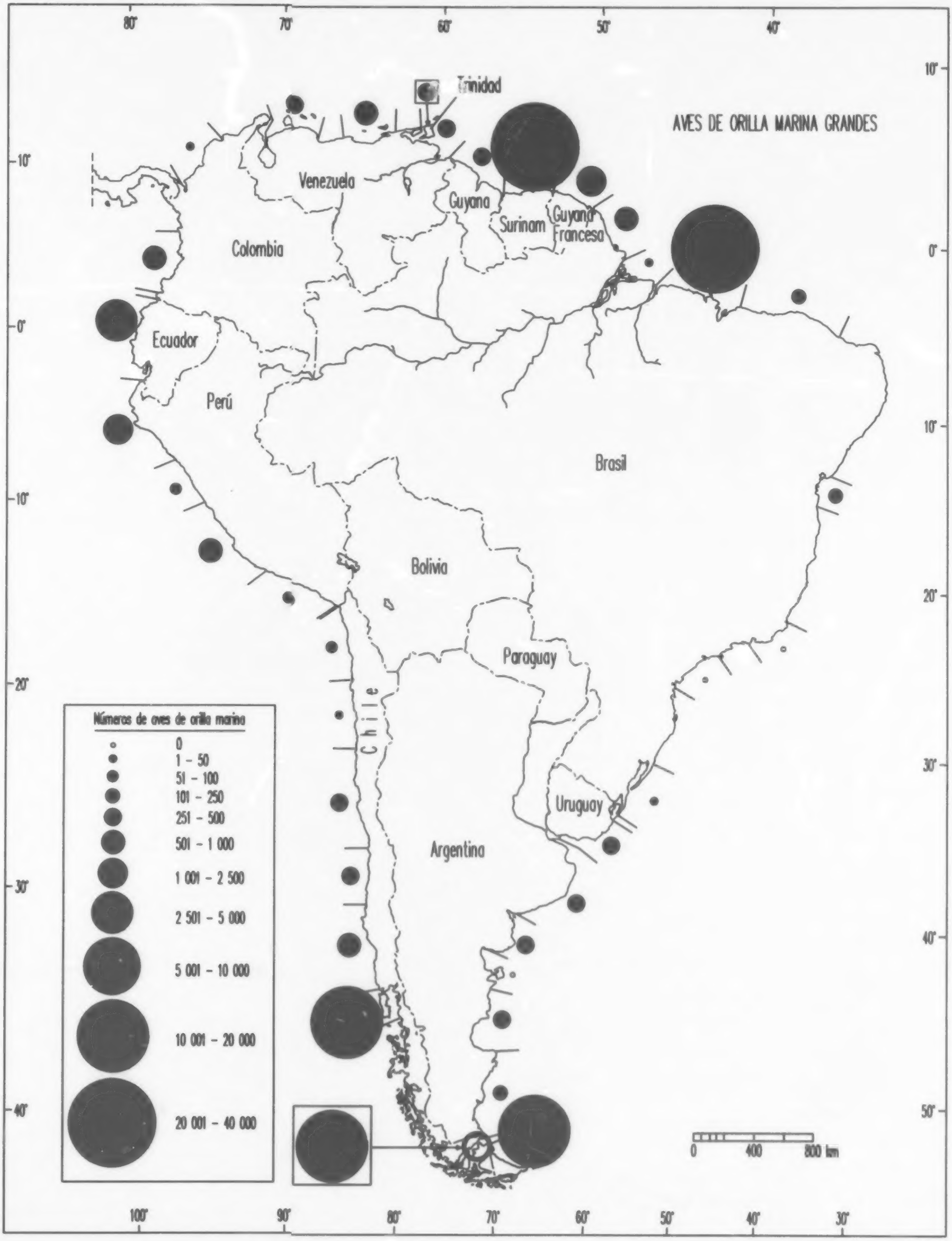
Las más importantes concentraciones de agujas de mar ocurrieron en Tierra del Fuego, cerca a 19 500 (42.8%) en Argentina y casi 11 700 (25.6%) en Chile. El sitio más importante fue la bahía San Sebastián, Argentina, sobre la costa atlántica de Tierra del Fuego, donde 19 400 agujas de mar fueron halladas sobre vastos fangales canalados protegidos por los 18 km de cascajos en la Península del Paramo. Este solo lugar, contiene el 42.5% del total de América del Sur, siendo esta un área de reputada importancia internacional. Las aves remanentes en Tierra del Fuego, Argentina, fueron halladas en las partes altas a lo largo de la costa atlántica. El segundo lugar de importancia individual fue la bahía Lomas, la mayor tierra de invernada del playero de pecho rojo, 60 km al norte del lado este de la boca del estrecho de Magallanes. La vasta llanura y los canales horizontales de esta bahía contenieron más de 10 500 aves (23.1%). Las aves remanentes (1 140) en el sector chileno de Tierra del Fuego, fueron halladas en la boca de bahía Lomas en la playa norte del estrecho de Magallanes.

Pequeños números fueron raramente encontrados hacía el norte a lo largo de la costa atlántica tan lejos como el norte del Uruguay. En las áreas del sur a lo largo de la línea costera de la Patagonia de Argentina, más agujas de mar, fueron halladas en zonas altas, por ejemplo cerca a Puerto Deseado (160) y hacía el sur a lo largo de Caleta Olivia (350) al sur de Commodoro Rivadavia. Sobre la mitad norte de la línea costera de Argentina, las agujas de mar fueron observadas en áreas estuarinas, por ejemplo en

Mapa 3.8
Distribución de becasinas (*Limnodromus* spp.) a lo largo de la costa de América del Sur

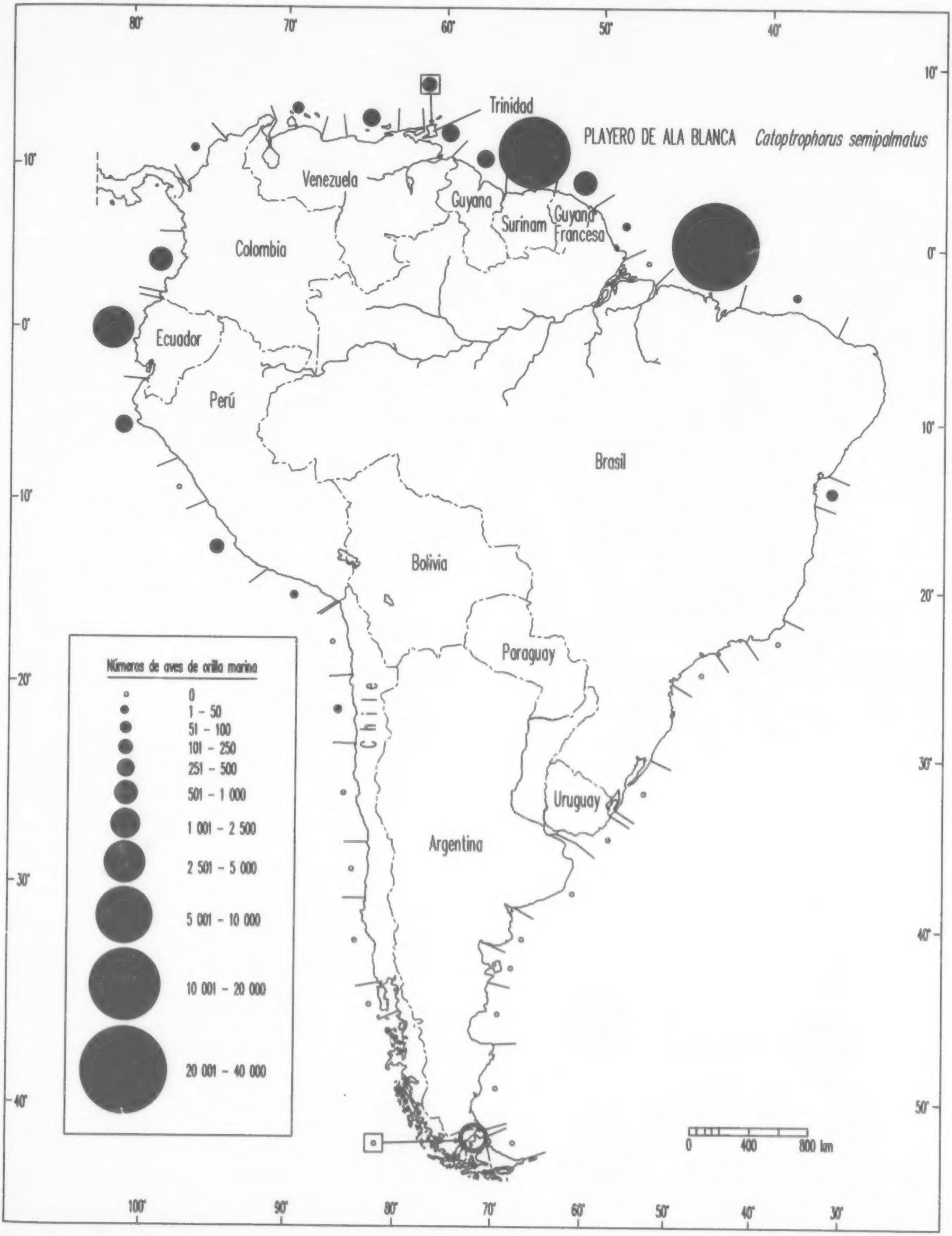

BECASINAS *Limnodromus* spp.
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.9
Distribución de aves de orilla marina grandes a lo largo de la costa de América del Sur

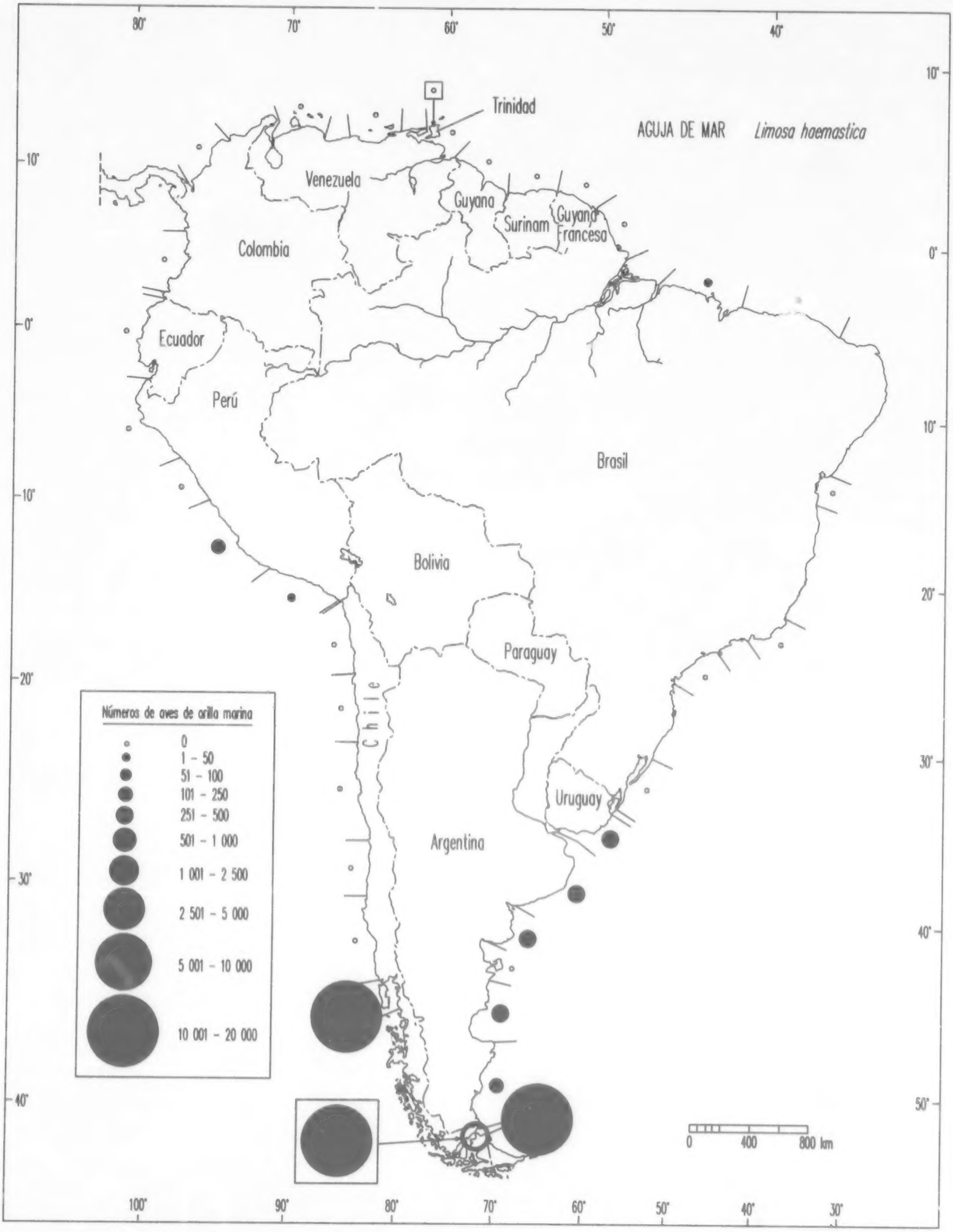


AVES DE ORILLA MARINA GRANDES
Trinidad
Venezuela
Colombia
Guyana
Surinam
Guyana Francesa
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.10
Distribución de playeros de ala blanca (*Catoptrophorus semipalmatus*) a lo largo de la costa de América del Sur


PLAYERO DE ALA BLANCA *Catoptrophorus semipalmatus*
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°

Mapa 3.11
Distribución de aguja de mar (*Limosa haemastica*) a lo largo de la costa de América del Sur


AGUJA DE MAR *Limosa haemastica*
Trinidad
Venezuela
Colombia
Guyana
Surinam
Guyana Francesa
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
100°
90°
80°
70°
60°
50°
40°
30°
10°
0°
10°
20°
30°
40°
50°
10°
0°
10°
20°
30°
40°

extensas áreas de Bahía Unión y Bahía Anegada (310) al sur de la entrada del río Colorado, y sobre las partes planas al sur de la Bahía Samborombon (430) al oeste de Punta Rasa en la Provincia de Buenos Aires. En Uruguay, las aves fueron halladas principalmente en lagunas de agua dulce y salubre, incluyendo la Laguna de Rocha (215), Laguna de Castillos (50) y Lagoa Mirim (60). Aunque ambos hábitats de lagunas y tierra adentro son usados por las especies en Uruguay y la Provincia de Buenos Aires (Myers y Myers 1979), las mayores áreas de invernada fueron identificadas en las evaluaciones sobre la costa y la parte sur del continente.

Las mayores concentraciones invernantes fueron también halladas en el área de Chiloé, la cual contiene más de 12 600 (27.8% del total de América del Sur) de las 12 800 aves registradas en la costa pacífica. La mayoría de las aves ocurrieron en la isla de Chiloé, especialmente en las entradas del golfo de Ancud donde el rango total del sector fue desde 250 a cerca de 2 000 aves. Grandes cantidades (2 900) fueron halladas en la entrada similar de Puerto Montt y sobre el largo delta este de Puerto Montt en la orilla norte del golfo de Ancud. Aunque muchas de las entradas fueron completamente escarpadas, también frecuentemente tienen grandes deltas pantanosos o complejos alcanzando en su parte de arriba, algunas veces asociados con fangales, habiendo sito esta una de las áreas en que más agujas de mar fueron encontradas.

Hubieron también registros en otros lugares, siendo el más notable el de 170 aves en la región del río Pisco en la costa sur central del Perú.

La migración de la aguja de mar, es una de las más espectacularmente conocidas. Recientemente, por los años 1940, la especie estuvo al borde de la extinción, existiendo relativamente pocos individuos y todavía lo son algunas que han sido vistos en la costa este de Norte América. Desde las tierras de reproducción en el Artico central canadiense, las especies previa a la migración se reunen en grandes concentraciones en las costas de Hudson Bay y James Bay, tal como lo indicaron primeramente los reportes de ornitólogos (Hope y Shortt 1944) y últimamente confirmado por unas extensas evaluaciones aéreas (Morrison y Harrington 1979; Morrison 1983, 1984), el cual tiene concentraciones localizadas de más de 10 000 aves en una sola localidad. Desde las costas de James Bay las aves partieron en vuelo directo a América del Sur (Hagar 1966): la siguiente área en la cual han sido reportados números substanciales es en la Provincia de Buenos Aires en Argentina, aunque los patrones de migración desde las áreas de descanso no han sido todavía descubiertas en alguna parte del norte de América del Sur (Morrison 1984).

De este modo parece que igualmente las poblaciones invernantes en Tierra del Fuego, derivan desde las tierras de reproducción en el Artico central canadiense. Si las poblaciones invernantes en la región de Chiloé migran a y desde las áreas de reproducción en el oeste de Ártico o en Alaska, todavía está por determinarse.

3.2.12. Zarapito trinador *Numenius phaeopus*

El zarapito trinador está poco extensamente distribuido en América del Sur, aunque las tres mayores áreas de concentración fueron aparentemente según las evaluaciones: la costa nor-central de Brasil, Surinam y la isla de Chiloé en Chile (Mapa 3.12.). La mayoría (61.3%) del total de 24 900 de zarapitos trinador observados en la evaluación, ocurrieron en la costa norte del continente, con números substanciales (37.8%) en la costa pacífica, y pocos (0.8%) en la costa atlántica.

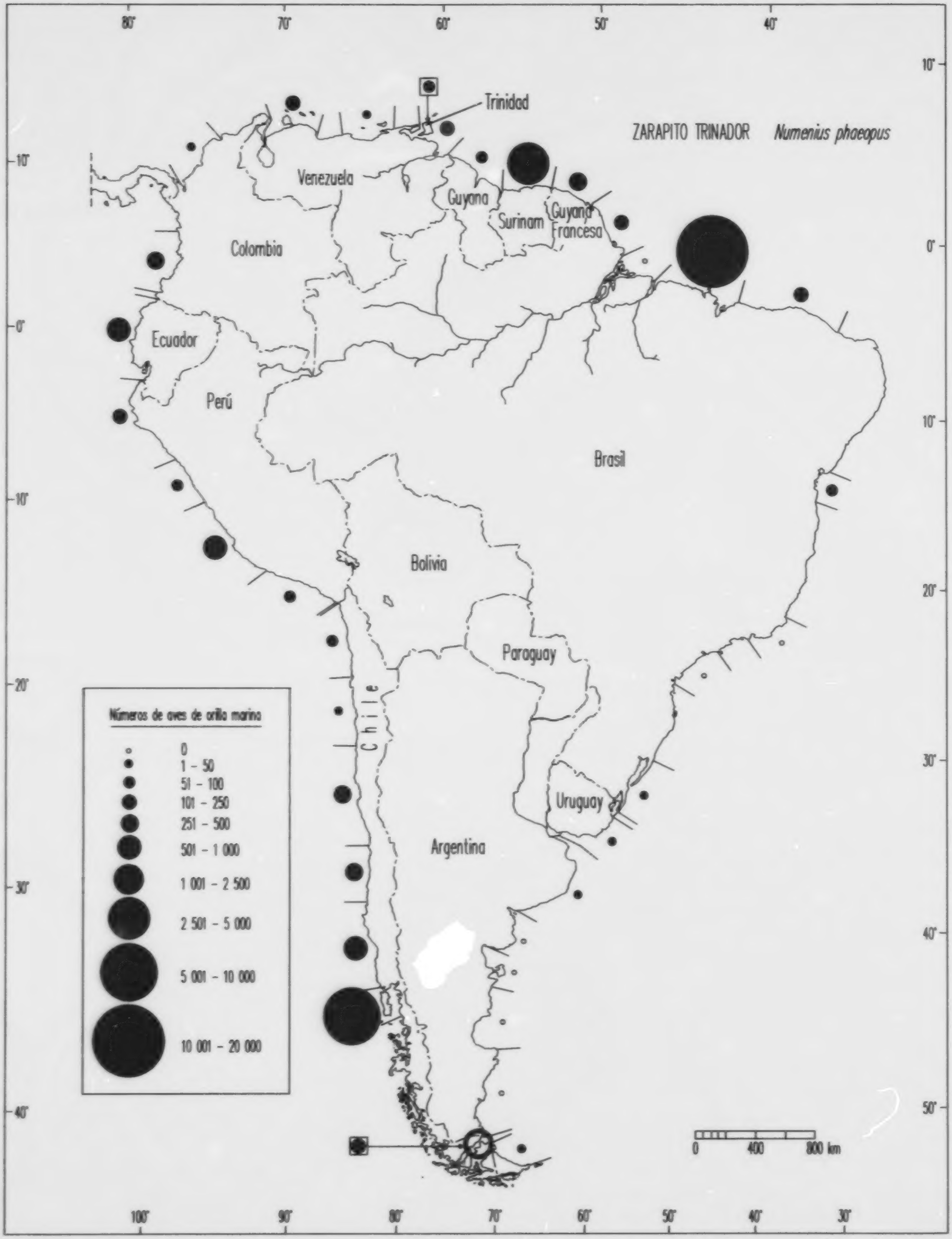
En la costa norte, el zarapito trinador estuvo asociado con áreas planas extensas de intermareas y manglares, especialmente donde ocurrieron bancos y fangales planos densos. Estos hábitats fueron abundantes en la costa nor-central de Brasil, el cual sostuvo el 43.7% del total de América del Sur (71.3% del total de 15 300 de la costa norte), así como también en Surinam el cual sostuvo el 13.3% del total de América del Sur. El zarapito trinador ocurrió en hábitats similares en pequeños números en otros lugares a lo largo de la costa norte.

En la costa pacífica, fueron halladas grandes cantidades en el área de Chiloé (6 200, 25.0% del total de América del Sur). La especie estuvo ampliamente distribuida a lo largo del norte y particularmente de la costa este de la isla de Chiloé en la entrada del golfo de Ancud—sector total, con rangos desde 30 a cerca de 700 aves, para un total de más de 2 800 aves. Muchas de las entradas de los corredores a la espalda de la costa, continua de pequeños a justamente extensos deltas de pantanales, o humedales, algunas veces asociadas con fangales y en donde fue hallado el zarapito trinador. Las mas grandes concentraciones en tales entradas, fueron descubiertas al oeste de Puerto Montt, conteniendo 1 100 aves. Otras 740 aves fueron localizadas en extensas complejos estuarinos alrededor de Maullin.

El zarapito trinador fue encontrado en pequeños números esparcidos a lo largo de la costa pacífica utilizando una variedad de hábitats, principalmente playas de oceano en el norte, a lo largo de la costa de Chile y a través del Perú (930 aves, 3.8%). En Ecuador (560 aves, 2.3%) y en la costa pacífica de Colombia (320 aves, 1.3%), el zarapito fue nuevamente más común en la línea de costa de los manglares con duros substratos fangosos, particularmente a lo largo de la costa este continental del golfo de Guayaquil y la línea costera colombiana entre el borde ecuatoriano y la bahía de Buenaventura.

Pequeños números fueron hallados en la costa atlántica, principalmente en hábitats de manglares en el área del Salvador en Brasil y sobre las bahías y las entradas alrededor del estrecho de Magallanes en Chile.

Mapa 3.12
Distribución del zarapito trinador (*Numenius phaeopus*) a lo largo de la costa de América del Sur



ZARAPITO TRINADOR *Numenius phaeopus*
Trinidad
Venezuela
Guyana
Surinam
Guyana Francesa
Colombia
Ecuador
Perú
Brasil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Números de aves de orilla marina
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
30°

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Capítulo 3

Apanhado geral

R.I.G. Morrison e R.K. Ross
Tradução de Paulo de Tarso Zuquim Antas

3.1. Padrões gerais de distribuição de aves litorâneas neárticas na América do Sul

Os sobrevôos cobriram cerca de 28.000 km de costa marítima da América do Sul e incluiram todas as seções consideradas como de significância para habitats de aves litorâneas. Mais de 2,9 milhões de aves das famílias Charadriidae e Scolopacidae provenientes do Hemisfério Norte foram contados ao longo dos censos. Os totais, subdivididos pelo porte das espécies nos vários países, estão na tabela 3.1. Espécies de porte pequeno predominam (p[illegible] ver a composição de cada categoria de tamanho veja capítulo 2), compreendendo 79,7% do total, com as espécies de porte médio e grande representando 15,7% e 4,2%, respectivamente. Aves não encaixadas em qualquer categoria representaram 0,4% do total.

Baseando-se somente nos números, a costa setentrional da América do Sul foi claramente a área de invernada mais importante para os maçaricos e batuíras neárticos, com cerca de 2,5 milhões ou 85,6% do total para o continente, com a costa pacífica tendo 218.000 (ou 7,5%) e a porção atlântica 203.000 (ou 7,0%) (Tabela 3.2). Esse resultado espelha a abundância das espécies de pequeno porte na costa norte e que outras áreas foram de maior importância para outros grupos de espécies ou mesmo uma única espécie. Mesmo na costa setentrional, a maior concentração de aves estava centrada nas Guianas, com o Suriname (57,9%) e a Guiana Francesa (16,9%) juntos abrigando 75% do total para o continente. Outras áreas importantes incluiram o Brasil (10,9%) e partes do Peru (3,9%), Chile (2,2%) e Argentina (1,8%). Para o grupo de médio porte, também a costa norte foi importante: 42,2% do total ocorreu nas Guianas (Suriname - 32,4%, Guiana Francesa - 7,2% e Guiana - 2,5%). Números importantes chegaram ao Brasil (24,1%), Chile (9,7%), Venezuela (7,1%), Argentina (6,6%) e Peru (5,1%). O Brasil abrigou a maior porcentagem do total de espécies de grande porte com 29%, com outras importantes áreas de invernada para espécies desse grupo no Chile (26,4%), Suriname (17,8%) e Argentina (17,2%).

3.2. Distribuição dos principais grupos e espécies de aves litorâneas neárticas na América do Sul

Para descrever melhor os padrões de distribuição dos maçaricos na América do Sul a costa do continente foi subdividida em 36 "eco-unidades", cada uma representando uma unidade geográfica, ecológica ou política, com uma característica ecológica distinta (veja Figura 2.2, capítulo 2). Totais de maçaricos ocorrendo em cada "eco-unidade" estão reunidos por categoria de tamanho na Tabela 3.2 e por espécie na Tabelas 3.3*a*–*c*. Padrões de distribuição para as várias categorías e espécies estão nos mapas 3.1 a 3.12. As localizações das pincipais áreas de invernada estão indicadas no interior da capa frontal do Atlas.

3.2.1. Aves litorâneas de pequeno porte

A distribuição dos aves litorâneas dessa classe de tamanho está no mapa 3.1. Consiste principalmente de aves do gênero *Calidris*, assim como as espécies menores de *Charadrius*. Em geral, durante o sobrevôo, foi impossível diferençá-las dada a grande similaridade entre si das espécies desses genêros, com excepção de *Calidris alba*. Esse último é identificável devido a suas características únicas e ocorrência em praias oceânicas (veja 3.2.2). *Actitis macularia* pode ser frequentemente identificado nas áreas com baixa densidade de aves, embora possa passar desapercebido quando grupos grandes de várias espécies estão presentes.

Apesar desses fatores limitantes afetando a identificação tanto observações feitas a partir da aeronave quando do solo indicaram que os grandes bandos de batuíras pequenas ocorrendo nos vários pontos do continente em geral consistiam de uma única espécie predominante. Na costa setentrional, esse foi o caso de *Calidris pusilla*, enquanto na porção meridional da costa atlântica, desde o sul do Brasil até a Terra do Fogo, a dominância foi de *C. fuscicollis*. Dessa forma, os padrões apresentados no Mapa 3.1 dessas duas áreas podem ser toma dos como representativos para essas duas espécies na América do Sul.

Uma série de características gerais surgem a partir do Mapa 3.1. O maior número de maçaricos pequenos, principalmente *Calidris pusilla*, ocorre no norte da América do Sul, em especial no Suriname e Guiana. Do total de mais de 2.083.000 batuíras dessa classe de tamanho presentes maquela porção do continente, 64,6% estavam no Suriname, 18,9% na Guiana Francesa e 0,5% na Guiana. O somatório desses porcentuais indica que 84% das aves estavam nessa região. Outras áreas relevantes no norte da costa sul-americana foram o litoral entre Belém e São Luís, no Brasil (9,2%) e o delta do rio Orinoco (3,3%).

Relativamente poucos aves litorâneas de pequeno porte estavam no centro da costa atlântica, apesar da existência de estuários e baias com coroas de lama e manguezais na área de Salvador. Um fenômeno similar foi observado na parte norte da costa pacífica, onde muitas áreas

Tabela 3.1
Totais por país de aves litorâneas neárticas inumeradas durante sondagens aéreas do litoral da América do Sul, entre 1982 e 1986

País/parâmetro	Distância da sondagem (km)	Aves litorâneas pequenas	Aves litorâneas médias	Aves litorâneas grandes	Aves litorâneas não classificadas	Total das aves litorâneas
Venezuela	1 938,0					
Número de aves		94 476	32 473	1 405	1 411	129 765
% do total por tamanho (América do Sul)		4,06	7,10	1,16	10,77	4,45
% do total geral (América do Sul)		3,24	1,11	0,05	0,05	4,45
Trinidade	483,8					
Número de aves		12 393	986	259	0	13 638
% do total por tamanho (América do Sul)		0,53	0,22	0,21	0,00	0,47
% do total geral (América do Sul)		0,42	0,03	0,01	0,00	0,47
Guiana	478,5					
Número de aves		9 808	11 618	340	0	21 766
% do total por tamanho (América do Sul)		0,42	2,54	0,28	0,00	0,75
% do total geral (América do Sul)		0,34	0,40	0,01	0,00	0,75
Suriname	369,8					
Número de aves		1 346 625	148 168	21 536	10 000	1 526 329
% do total por tamanho (América do Sul)		57,85	32,42	17,75	76,31	52,28
% do total geral (América do Sul)		46,13	5,08	0,74	0,34	52,28
Guiana Francesa	388,2					
Número de aves		394 334	32 906	2 094	1 500	430 834
% do total por tamanho (América do Sul)		16,94	7,20	1,73	11,45	14,76
% do total geral (América do Sul)		13,51	1,13	0,07	0,05	14,76
Brasil	7 852,5					
Número de aves		252 812	110 258	35 147	0	398 217
% do total por tamanho (América do Sul)		10,86	24,12	28,97	0,00	13,64
% do total geral (América do Sul)		8,66	3,78	1,20	0,00	13,64
Uruguai	621,9					
Número de aves		3 137	6 960	422	0	10 519
% do total por tamanho (América do Sul)		0,13	1,52	0,35	0,00	0,36
% do total geral (América do Sul)		0,11	0,24	1,01	0,00	0,36
Argentina	4 549,0					
Número de aves		41 429	30 195	20 806	194	92 624
% do total por tamanho (América do Sul)		1,78	6,61	17,55	1,48	3,17
% do total geral (América do Sul)		1,42	1,03	0,71	0,01	3,17
Chile	5 487,5					
Número de aves		51 186	44 432	32 019	0	127 637
% do total por tamanho (América do Sul)		2,20	9,72	26,39	0,00	4,37
% do total geral (América do Sul)		1,75	1,52	1,10	0,00	4,37
Peru	2 774,3					
Número de aves		89 675	23 367	2 234	0	115 276
% do total por tamanho (América do Sul)		3,85	5,11	1,84	0,00	3,95
% do total geral (América do Sul)		3,07	0,80	0,08	0,00	3,95
Equador	1 385,5					
Número de aves		2 274	3 485	4 006	0	9 765
% do total por tamanho (América do Sul)		0,10	0,76	3,30	0,00	0,33
% do total geral (América do Sul)		0,08	0,12	0,14	0,00	0,33
Colômbia	1 600,6					
Número de aves		29 673	12 238	1 049	0	42 960
% do total por tamanho (América do Sul)		1,27	2,68	0,86	0,00	1,47
% do total geral (América do Sul)		1,02	0,42	0,04	0,00	1,47
Total	27 929,6	2 327 822	457 086	121 317	13 105	2 919 330
% do total geral (América do Sul)		79,74	15,66	4,16	0,45	100,00

com habitats estuárinos (como o Golfo de Guayaquil e a Bahia de Buenaventura) abrigavam poucos maçaricos dessa classe de tamanho.

Estudos usando anilhamento (Morrison e Spaans, 1979; Spaans, 1984), peles de museus (dados inéditos) e observações de campo (Spaans 1978, 1979) mostram que a maioria das batuíras da costa norte eram *Calidris pusilla*, embora *Calidris mauri*, muito parecido, também esteja presente. Grandes números de *C. mauri* ocorrem em migrações na costa ocidental da América do Norte (como no delta do rio Copper e no delta do rio Fraser — Senner *et al.*, 1981). Já a proporção de *C. mauri* nas áreas de invernada da costa norte da América do Sul é baixa e os números relativamente pequenos de batuíras dessa classe de tamanho foram anotadas para o nordeste da porção ocidental sul-americana. Essas informações sugerem que a principal área de invernada dessa espécie pode situar-se ao norte do continente sul-americano. Números significativos foram relatados recentemente para o Panamá, por exemplo (R.I.G. Morrison, R.K. Ross e F. Delgado, dados inéditos; B.A. Harrington, J.P. Myers, com. pers.).

Calidris pusilla apresenta um cline leste/oeste do Artico de tamanho através de sua área de reprodução, sendo as aves do leste maiores que as do Alaska (Harrington e Morrison, 1979). Esse cline é refletido nas medidas tiradas ao longo da costa setentrional da América do Sul, indi-

Tabela 3.2
Sumário por categoria de tamanhos de aves litorâneas neárticas em regiões e eco-unidades do litoral da América do Sul

Região/eco-unidade	Distância da eco-unidade (km)	Aves litorâneas pequenas	Aves litorâneas médias	Aves litorâneas grandes	Aves litorâneas não classificadas	Total das aves litorâneas
Costa Norte						
Colômbia - Caribe	853,7	4 955	6 014	50	0	11 019
Venezuela - Caribe Occidental	1 113,2	9 640	10 205	406	1 411	21 662
Venezuela - Caribe Central	275,6	15 203	8 240	519	0	23 962
Venezuela - Orenoco	549,2	69 633	14 028	480	0	84 141
Trinidade	483,8	12 393	986	259	0	13 638
Guiana	478,5	9 808	11 618	340	0	21 766
Suriname	369,8	1 346 625	148 168	21 536	10 000	1 526 329
Guiana Francesa	388,2	394 334	32 906	2 094	1 500	430 834
Brasil - Norte	464,3	25 598	2 323	674	0	28 595
Brasil - Amazonas	633,8	2 080	621	7	0	2 708
Brasil - Norte/Central	2 504,7	195 531	97 227	34 133	0	326 891
Brasil - Nordeste	1 248,4	3 009	2 760	183	0	5 952
Total regional (costa Norte)	9 363,2	2 088 809	335 096	60 681	12 911	2 497 497
Costa do Atlântico						
Brasil - Leste	939,0	1 817	679	143	0	2 639
Brasil - Rio	394,9	688	4 885	0	0	5 573
Brasil - São Paulo	784,5	11	1	0	0	12
Brasil - Rio Grande do Sul	882,9	24 078	1 762	7	0	25 847
Uruguai	621,9	3 137	6 960	422	0	10 519
Argentina - Buenos Aires	921,8	1 625	1 994	482	103	4 204
Argentina - Rio Colorado	910,5	4 967	1 846	318	0	7 131
Argentina - Península Valdes	784,9	1 815	5 086	0	1	6 902
Argentina - Golfo San Jorge	730,9	7 559	9 128	357	90	17 134
Argentina - Rio Gallegos	770,9	1 700	550	163	0	2 413
Argentina - Terra do Fogo	430,0	23 763	11 591	19 486	0	54 840
Chile - Terra do Fogo	619,2	11 210	43 206	11 779	0	66 195
Total regional (costa do Atlântico)	8 791,4	82 370	87 688	33 157	194	203 409
Costa do Pacífico						
Chile - Chiloé	1 432,0	19 164	789	18 856	0	38 809
Chile - Conceição	880,7	4 563	51	617	0	5 231
Chile - Valparaíso	543,0	9 166	87	384	0	9 637
Chile - La Serena	846,2	4 395	108	291	0	4 794
Chile - Antofagasta	582,8	1 327	128	33	0	1 488
Chile - Arica	583,6	1 361	63	59	0	1 483
Peru - Mollendo	683,9	14 854	6 393	81	0	21 328
Peru - Lima	792,7	19 995	2 335	988	0	23 318
Peru - Chimbote	426,1	2 171	435	65	0	2 671
Peru - Chiclayo	871,6	52 655	14 204	1 100	0	67 959
Equador	1 385,5	2 274	3 485	4 006	0	9 765
Colômbia - Pacífico	746,9	24 718	6 224	999	0	31 941
Total regional (costa do Pacífico)	9 775,0	156 643	34 302	27 479	0	218 424
Total	27 929,6	2 327 822	457 086	121 317	13 105	2 919 330

cando que as aves maiores na costa do Brasil provavelmente provêem de locais de reprodução do leste, com as aves menores correndo na parte oeste da costa caribenha e na costa pacífica da América do Sul. Essas últimas devem ter sua origem em áreas de reprodução no oeste do Ártico (Morrison, 1983, 1984).

Concentrações moderadas de aves litorâneas pequenas foram notadas na porção sul da costa atlântica, especialmente no Rio Grande do Sul, no Brasil, e Terra do Fogo (Argentina e Chile). Observações e trabalhos de anilhamento mostram que poucos *Calidris pusilla* chegam até essa área do continente e que a espécie dominante é *Calidris fuscicollis*. As áreas de invernada mais importantes descobertas nessa porção da América do Sul estavam na costa atlântica da Terra do Fogo (31,9% do total regional de 73.000 batuíras); a parte chilena da Terra do Fogo, especialmente as áreas em torno do Estreito de Magalhães, abrigavam outros 15,3% do total regional. Outra área particularmente importante foram as lagoas do estado do Rio Grande do Sul, no Brasil, em destaque a Lagoa do Peixe. Essas lagoas retinham 20,7% do total regional com as lagoas costeiras uruguaias abrigando outros 4,3%. Números menores surgiram ao longo da costa atlântica da Argentina, os setores mais importantes ocorrendo em torno do Golfo San Jorge.

A maioria das aves ocorreram ao longo da formação rochosa conhecida como "restinga" na Argentina, nas áreas entremarés da parte rochosa ou coroas de lama, ou em lagunas. Poucos habitats interiores foram sobrevoados na áreas costeiras da Província de Buenos Aires, apesar de serem conhecidos como locais importantes de invernada de *Calidris fuscicollis* e *Calidris bairdii* (Myers e Myers, 1979).

3.2.2. *Calidris alba*

Cerca de 112.000 *Calidris alba* foram anotados durante os sobrevôos. As áreas principais de invernada dessa espécie situaram-se nas extensas praias oceânicas da costa pacífica (Mapa 3.2), as quais abrigavam 87,8% do total, com as costas atlântica e norte albergando somente 8,3% e 3,9% do total pela ordem. *C. alba* era a espécie mais numerosa dessa classe de tamanho ao longo das praias do Pacífico, chegando a 94-100% das aves dessa

Tabela 3.3*a*
Total das espécies de aves litorâneas neárticas nas regiões e eco-unidades do litoral da América do Sul—Aves pequenas

Região/eco-unidade	Distância da eco-unidade (km)	*Charadrius semipalmatus*	*Actitis macularia*	*Tringa solitaria*	*Calidris melanotos*	*Calidris fuscicollis*	*Calidris alba*	Espécies não identificadas de aves litorâneas pequenas	Total das espécies de aves litorâneas pequenas
Costa Norte									
Colômbia - Caribe	853,7	0	28	0	0	0	56	4 871	4 955
Venezuela - Caribe Ocidental	1 113,2	0	10	0	0	0	194	9 436	9 640
Venezuela - Caribe Central	275,6	0	1	0	0	0	0	15 202	15 203
Venezuela - Orenoco	549,2	0	7	0	0	0	460	69 166	69 633
Trinidade	483,8	0	21	0	0	0	5	12 367	12 393
Guiana	478,5	0	23	0	0	0	30	9 755	9 808
Suriname	369,8	0	10	0	0	0	42	1 346 573	1 346 625
Guiana Francesa	388,2	0	5	0	0	0	2	394 327	394 334
Brasil - Norte	464,3	0	2	0	0	0	2	25 594	25 598
Brasil - Amazonas	633,8	470	4	0	0	0	117	1 489	2 080
Brasil - Norte/Central	2 504,7	0	246	1	0	0	3 080	192 204	195 531
Brasil - Nordeste	1 248,4	0	3	0	0	0	380	2 626	3 009
Total regional (costa Norte)	9 363,2	470	360	1	0	0	4 368	2 083 610	2 088 809
Costa do Atlântico									
Brasil - Leste	939,0	0	20	1	65	0	261	1 470	1 817
Brasil - Rio	394,9	0	2	0	0	0	524	162	688
Brasil - San Paulo	784,5	0	0	0	0	0	0	11	11
Brasil - Rio Grande do Sul	882,9	0	0	0	1	2 340	6 618	15 119	24 078
Uruguai	621,9	0	3	0	0	1	5	3 128	3 137
Argentina - Buenos Aires	921,8	0	0	0	0	0	253	1 372	1 625
Argentina - Rio Colorado	910,5	0	0	0	0	0	240	4 727	4 967
Argentina - Península Valdes	784,9	0	0	0	0	0	777	1038	1 815
Argentina - Golfo San Jorge	730,9	0	0	0	0	0	75	7 484	7 559
Argentina - Rio Gallegos	770,9	0	0	0	0	0	0	1 700	1 700
Argentina - Terra do Fogo	430,0	0	0	0	0	0	504	23 259	23 763
Chile - Terra do Fogo	619,2	0	0	0	0	0	25	11 185	11 210
Total regional (costa do Atlântico)	8 791,4	0	25	1	66	2 341	9 282	70 655	82 370
Costa do Pacífico									
Chile - Chiloé	1 432,0	0	0	0	0	0	10 194	8 970	19 164
Chile - Conceição	880,7	0	0	0	0	0	4 543	20	4 563
Chile - Valparaíso	543,0	0	0	0	0	0	8 442	724	9 166
Chile - La Serena	846,2	0	0	0	0	0	4 395	0	4 395
Chile - Antofagasta	582,8	0	0	0	0	0	1 327	0	1 327
Chile - Arica	583,6	0	0	0	0	0	1 361	0	1 361
Peru - Mollendo	683,9	0	1	0	0	0	14 242	611	14 854
Peru - Lima	792,7	0	1	0	0	0	18 831	1 163	19 995
Peru - Chimbote	426,1	0	8	0	0	0	2 163	0	2 171
Peru - Chiclayo	871,6	0	23	0	0	0	31 610	21 022	52 655
Equador	1 385,5	0	5	0	0	0	230	2 039	2 274
Colômbia - Pacífico	746,9	0	8	0	0	0	827	23 883	24 718
Total regional (costa do Pacífico)	9 775,0	0	46	0	0	0	98 165	58 452	156 643
Total	27 929,6	470	431	2	66	2 341	111 815	2 212 697	2 327 822

categoria nas "eco-unidades" entre a Ilha Chiloé, no Chile, e a costa do Peru.

Nesses dois últimos países, 30,8% e 68,1%, respectivamente, dos *C. alba* estavam presentes, compreendendo entre ambos 98,9% do total da costa do Pacífico. As áreas mais importantes localizavam-se no norte do Peru, em especial na região de Chiclayo onde cerca de 32.000 (32,2% do total do Pacífico) aves foram anotadas. Outras áreas destacadas incluem a costa próxima a Pacasmayo, onde acima de 11.000 aves foram vistas e a enorme praia oceânica em frente ao Deserto de Sechura. Praias do Peru central e meridional também abrigavam grandes números com 19,1% e 14,5% do total dessa costa. Grandes e moderadas concentrações ocorreram ao longo das praias centrais e meridionais do Chile, sendo que a região de Chiloé abrigou 10,4% do total do Pacífico. Mais de 2.500 *C. alba* foram vistos próximo a Coulin, na parte norte da Ilha Chiloé.

Já na costa atlântica, os números variavam de concentrações baixas para moderadas. As praias oceânicas do Rio Grande do Sul, Brasil, continham 70,5% do total regional de 9.300 aves. Praias próximas a lagunas costeiras, especialmente da Lagoa do Peixe, eram mais utilizadas.

Na costa setentrional os números cairam ainda mais, sendo que as 4.400 aves desse setor significam apenas 3,9% do total do continente. A maioria (71,3%) dessas aves foram vistas nos pontões de areia da costa altamente acidentada entre Belém e São Luís, especialmente nas regiões próximas a está última cidade.

Densidades assim como números eram mais altos na costa pacífica em relação à atlântica (veja também Morrison, 1984; Myers *et al.*, 1985). A maior densidade foi de 1.095 aves/km correspondente a bandos grandes (7.700 aves) no pequeno setor (7,03 km) cobrindo a foz do rio Pisco no Peru. Outro local com altas densidades foi o norte do Peru ao longo das costas fronteiras do Deserto de Sechura e áreas adjacentes. Os valores atingiram 278 aves/km perto de Pacasmayo e 186 aves/km na ponta noroeste da praia do Deserto de Sechura; a densidade média desse setor atingiu a 117 aves/km. Também no sul do Peru, na área próxima ao Chile, densidades importantes como 242 aves por quilómetro foram anotadas na

Tabela 3.3*b*
Total das espécies de aves litorâneas neárticas nas regiões e eco-unidades do litoral da América do Sul—Aves de tamanho médio

Região/eco-unidade	Distância da eco-unidade (km)	*Pluvialis dominica*	*Pluvialis squatarola*	*Arenaria interpres*	*Aphriza virgata*	*Tringa flavipes e melanoleuca*	*Calidris canutus*	Gênero *Limnodromus*	Espécies não identificadas de aves litorâneas de tamanho médio	Total das espécies de aves litorâneas de tamanho médio
Costa Norte										
Colômbia - Caribe	853,7	0	1 241	175	0	19	0	1 558	3 020	6 014
Venezuela - Caribe Ocidental	1 113,2	0	212	219	0	1 290	520	0	7 964	10 205
Venezuela - Caribe Central	275,6	0	48	0	0	779	0	7 113	300	8 240
Venezuela - Orenoco	549,2	0	143	42	0	308	0	3 100	10 435	14 028
Trinidade	483,8	0	173	6	0	518	0	209	80	986
Guiana	478,5	0	598	48	0	6 824	0	2 900	1 248	11 618
Suriname	369,8	0	3 940	619	0	66 377	0	21 840	55 392	148 168
Guiana Francesa	388,2	0	640	601	0	5 117	0	2 400	24 148	32 906
Brasil - Norte	464,3	47	676	191	0	205	120	20	1 064	2 323
Brasil - Amazonas	633,8	0	101	4	0	227	0	150	139	621
Brasil - Norte/Central	2 504,7	0	14 711	17 909	0	798	8 191	8 105	47 508	97 227
Brasil - Nordeste	1 248,4	82	1 289	433	0	218	15	35	688	2 760
Total regional (costa Norte)	9 363,2	129	23 772	20 247	0	82 686	8 846	47 430	151 986	335 096
Costa do Atlântico										
Brasil - Leste	939,0	0	168	321	0	59	0	0	131	679
Brasil - Rio	394,9	0	76	1	0	4 808	0	0	0	4 885
Brasil - San Paulo	784,5	0	0	0	0	0	0	0	1	1
Brasil - Rio Grande do Sul	882,9	629	3	0	0	419	0	0	711	1 762
Uruguai	621,9	3 167	365	253	0	88	0	0	3 087	6 960
Argentina - Buenos Aires	921,8	85	0	0	0	642	0	0	1 267	1 994
Argentina - Rio Colorado	910,5	30	5	0	0	1	50	0	1 760	1 846
Argentina - Península Valdes	784,9	0	5	0	0	55	5 023	0	3	5 086
Argentina - Golfo San Jorge	730,9	0	0	320	0	17	8 691	0	100	9 128
Argentina - Rio Gallegos	770,9	0	0	0	0	0	550	0	0	550
Argentina - Terra do Fogo	430,0	0	0	1	0	0	10 470	0	1 120	11 591
Chile - Terra do Fogo	619,2	0	0	2	0	14	42 762	0	428	43 206
Total regional (costa do Atlântico)	8 791,4	3 911	622	898	0	6 103	67 546	0	8 608	87 688
Costa do Pacífico										
Chile - Chiloé	1 432,0	0	0	0	20	164	0	0	605	789
Chile - Conceição	880,7	0	0	0	0	36	0	0	15	51
Chile - Valparaíso	543,0	0	2	0	20	10	0	0	55	87
Chile - La Serena	846,2	14	4	29	61	0	0	0	0	108
Chile - Antofagasta	582,8	0	0	113	15	0	0	0	0	128
Chile - Arica	583,6	1	22	6	4	0	0	0	30	63
Peru - Mollendo	683,9	0	587	156	45	918	0	0	4 644	6 393
Peru - Lima	792,7	0	440	582	0	497	0	0	756	2 335
Peru - Chimbote	426,1	0	114	259	30	30	0	0	2	435
Peru - Chiclayo	871,6	0	203	911	2	454	0	0	12 633	14 204
Equador	1 385,5	0	1 082	109	0	135	0	825	1 334	3 485
Colômbia - Pacífico	746,9	0	419	189	0	20	0	604	4 992	6 224
Total regional (costa do Pacífico)	9 775,0	15	2 873	2 354	197	2 368	0	1 429	25 066	34 302
Total	27 929,6	4 055	27 267	23 499	197	91 047	76 392	48 859	185 660	457 086

região de Tacna. Nos outros locais de Peru e Chile, as densidades variaram de 25-60 aves/km, um número relativamente alto. Já na costa atlântica, a maior densidade anotada foi no Rio Grande do Sul, perto da costa da Lagoa do Peixe com 69 aves/km; na costa norte o maior valor foi de 25 aves/km na área de São Luís.

Estudos usando anilhas coloridas feitos (Myers *et al.*, 1984) mostravam que muitos *C. alba* passando o inverno boreal na costa pacífica migravam para as áreas de reprodução do Ártico tanto via a costa ocidental da América do norte ou por uma rota central a partir da costa texana do Golfo do México através das pradarias norte-americanas. Na migração para o sul usam tanto a costa leste quanto o interior da América do Norte. Dessa forma, várias aves realizam uma migração quase eliptica, no sentido dos ponteiros do relógio. A maioria das aves migrando ao norte do longo da costa atlântica norte-americana através dos principais pontos de parada dessa costa, como a baía Delaware, não devem provir do litoral pacífico da América do Sul, mas provavelmente tem origem na costa Atlântica do continente sulamericano.

3.2.3. Aves litorâneas de porte médio

Em torno de 457.000 aves dessa classe de tamanho foram anotadas ao longo dos sobrevôos (Tabela 3.2). Vários locais de concentração surgiram, com diversas espécies predominando nos vários locais (Mapa 3.3, Tabela 3.3*b*). A costa norte do continente foi particularmente importante, em especial para *Pluvialis squatarola, Arenaria interpres, Tringa* spp. e *Limnodromus* spp. A região das Guianas abrigava 42,1% do total dessa classe de tamanho para toda a América do Sul (Suriname 32,4%, Guiana Francesa 7,2% e Guiana 2,5%), com a área entre Belém e São Luís, no Brasil, tendo números significativos (21,3%). O grande número de aves litorâneas de porte médio usando a Argentina (6,6%) e Chile (9,7%) era constituido principalmente por *Calidris canutus* nas costas da Terra do Fogo e Patagônia. Relativamente poucas aves

Tabela 3.3c
Total das espécies de aves litorâneas neárticas nas regiões e eco-unidades do litoral da América do Sul—Aves grandes

Região/eco-unidade	Distância da eco-unidade (km)	*Numenius phaeopus*	*Catoptrophorus semi-palmatus*	*Limosa haemastica*	Espécies não identificadas de aves litorâneas grandes	Total das espécies de aves litorâneas grandes
Costa Norte						
Colômbia - Caribe	853,7	29	21	0	0	50
Venezuela - Caribe Occidental	1 113,2	114	121	0	171	406
Venezuela - Caribe Central	275,6	5	464	0	50	519
Venezuela - Orenoco	549,2	207	273	0	0	480
Trinidade	483,8	75	184	0	0	259
Guiana	478,5	57	283	0	0	340
Suriname	369,8	3 310	15 646	0	2 580	21 536
Guiana Francesa	388,2	326	729	0	1 039	2 094
Brasil - Norte	464,3	138	25	0	511	674
Brasil - Amazonas	633,8	0	0	0	2	7
Brasil - Norte/Central	2 504,7	10 879	21 868	4	1 382	34 133
Brasil - Nordeste	1 248,3	117	26	0	40	183
Total regional (costa Norte)	9 363,2	15 257	39 640	4	5 775	60 681
Costa do Atlântico						
Brasil - Leste	939,0	66	77	0	0	143
Brasil - Rio	394,9	0	0	0	0	0
Brasil - San Paulo	784,5	0	0	0	0	0
Brasil - Rio Grande do Sul	882,9	3	0	0	4	7
Uruguai	621,9	2	0	326	94	422
Argentina - Buenos Aires	921,8	6	0	429	47	482
Argentina - Rio Colorado	910,5	0	0	313	5	318
Argentina - Península Valdes	784,9	0	0	0	0	0
Argentina - Golfo San Jorge	730,9	0	0	352	5	357
Argentina - Rio Gallegos	770,9	0	0	160	3	163
Argentina - Terra do Fogo	430,0	14	0	19 472	0	19 486
Chile - Terra do Fogo	619,2	119	0	11 660	0	11 779
Total regional (costa do Atlântico)	8 791,4	210	77	32 712	158	33 157
Costa do Pacífico						
Chile - Chiloé	1 432,0	6 210	0	12 642	4	18 856
Chile - Conceição	880,7	617	0	0	0	617
Chile - Valparaíso	543,0	384	0	0	0	384
Chile - La Serena	846,2	291	0	0	0	291
Chile - Antofagasta	582,8	31	2	0	0	33
Chile - Arica	583,6	59	0	0	0	59
Peru - Mollendo	683,9	79	1	1	0	81
Peru - Lima	792,7	620	156	170	42	988
Peru - Chimbote	426,1	65	0	0	0	65
Peru - Chiclayo	871,6	169	431	0	500	1 100
Equador	1 385,5	562	3 384	0	60	4 006
Colômbia - Pacífico	746,9	320	679	0	0	999
Total regional (costa do Pacífico)	9 775,0	9 407	4 653	12 813	606	27 479
Total	27 929,6	24 874	44 370	45 529	6 539	121 317

litorâneas de porte médio foram vistas ao longo das costas pacíficas do Chile e Peru. *P. squatarola* e *A. interpres* estavam entre as espécies dessa classe de tamanho mais frequentes naquelas praias. Junto com *Tringa* spp., *Pluvialis squatarola* e uma grande variedade de outras espécies ocorreram nos brejos costeiros. Números moderados de aves litorâneas de porte médio estavam nas coroas de lama da costa pacífica do Equador e Colômbia.

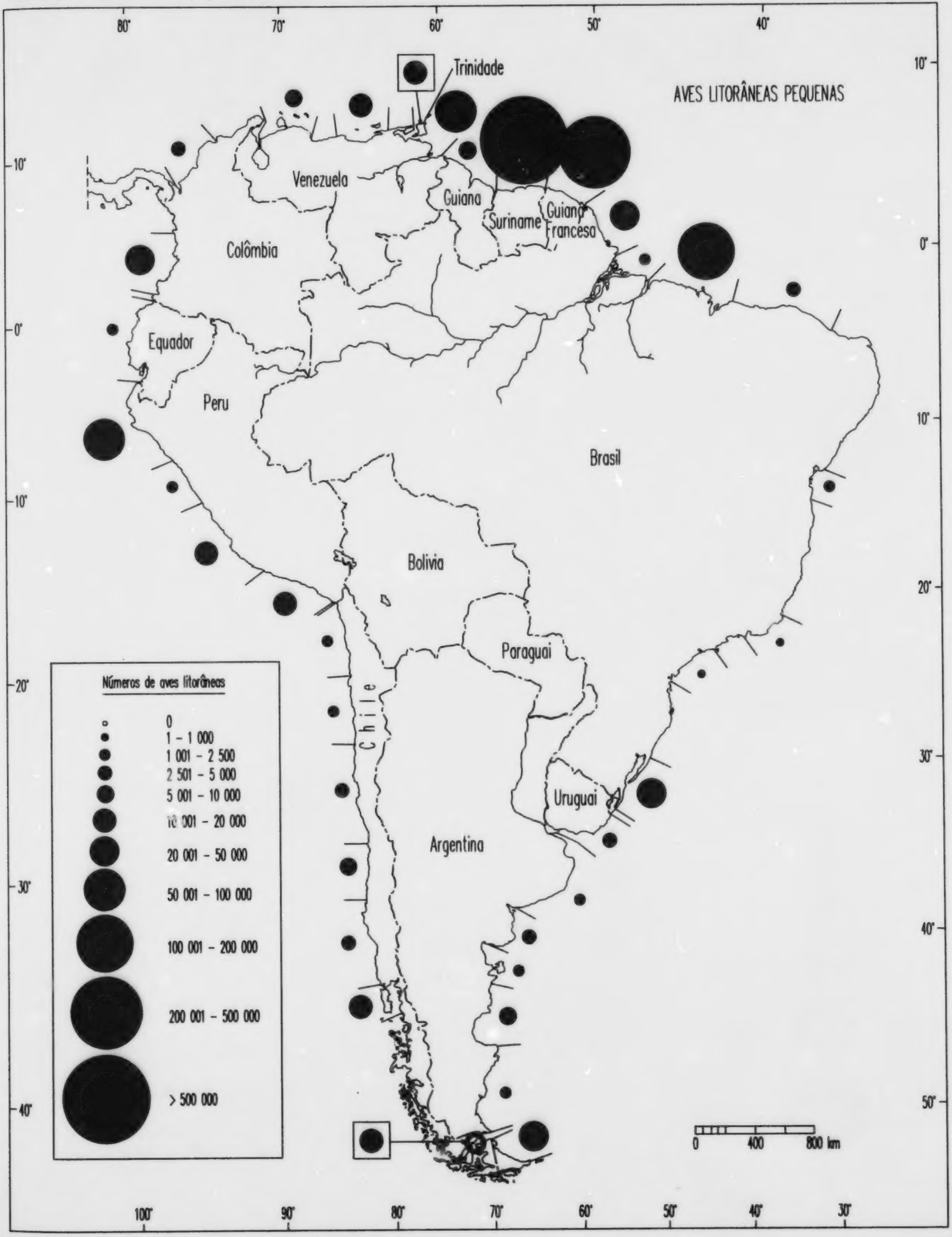
3.2.4. *Pluvialis squatarola*

As principais áreas de invernada de *P. squatarola* estão no litoral norte do continente, em especial na sua porção mais setentrional (Mapa 3.4). Do total de 27.300 aves anotadas no sobrevôo, 87,2% estavam na costa norte, com a costa pacífica abrigando 10,5% e a costa atlântica 2,3%.

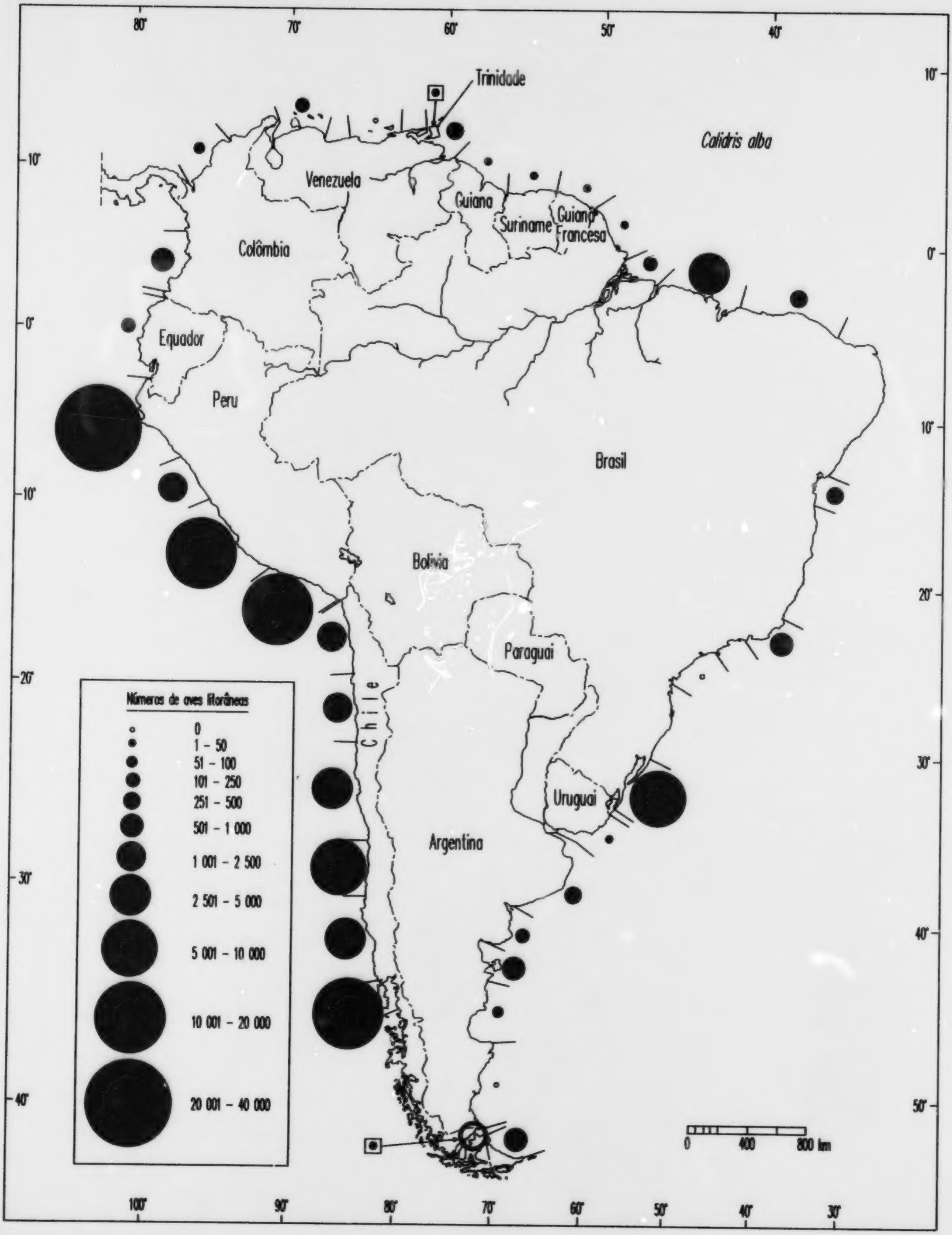
O litoral entre Belém e São Luís foi a mais importante área de invernada, com 14.700 aves, correspondente a 61,9% do total dessa região do continente e a 54,0% do total geral. Essa costa altamente recortada consiste de baíase penínsulas com enormes bancos de areia, coroas de lama, manguezais e praias, fornecendo extensos habitats de alimentação e repouso para as aves. A própria costa é muito grande; mais de 2.500 km foram sobrevoados nessa região. A densidade para toda a "eco-unidade" foi de 6 aves/km, com densidades de alguns setores chegando a 26 aves/km. Suriname é a próxima área em importância, com 16,6% do total regional (14,5% do total para o continente). A costa surinamesa é muito mais rectilínea, constituída por grandes coroas de lama alternando-se com seções de praias pantanosas. No geral, a densidade dessa unidade foi de 10,7 aves/km, com setores alcançando até 49 aves/km. A maioria dos setores não ultrapassou 20 aves/km.

Outras áreas destacáveis incluiam a costa caribenha da Colômbia (1.200 aves, 5,2% ou 4,6% do total regional e sul-americano, respectivamente) e litoral nordestino do Brasil (1.300 aves; 5,4% e 4,7% como o anterior). Na Colômbia, a maioria das aves estava em lagoas rasas adjacentes à costa, em especial aquelas próximas à foz do Rio Magdalena junto a Barranquilha. No nordeste brasileiro, as aves estavam ao longo das praias oceânicas, principal-

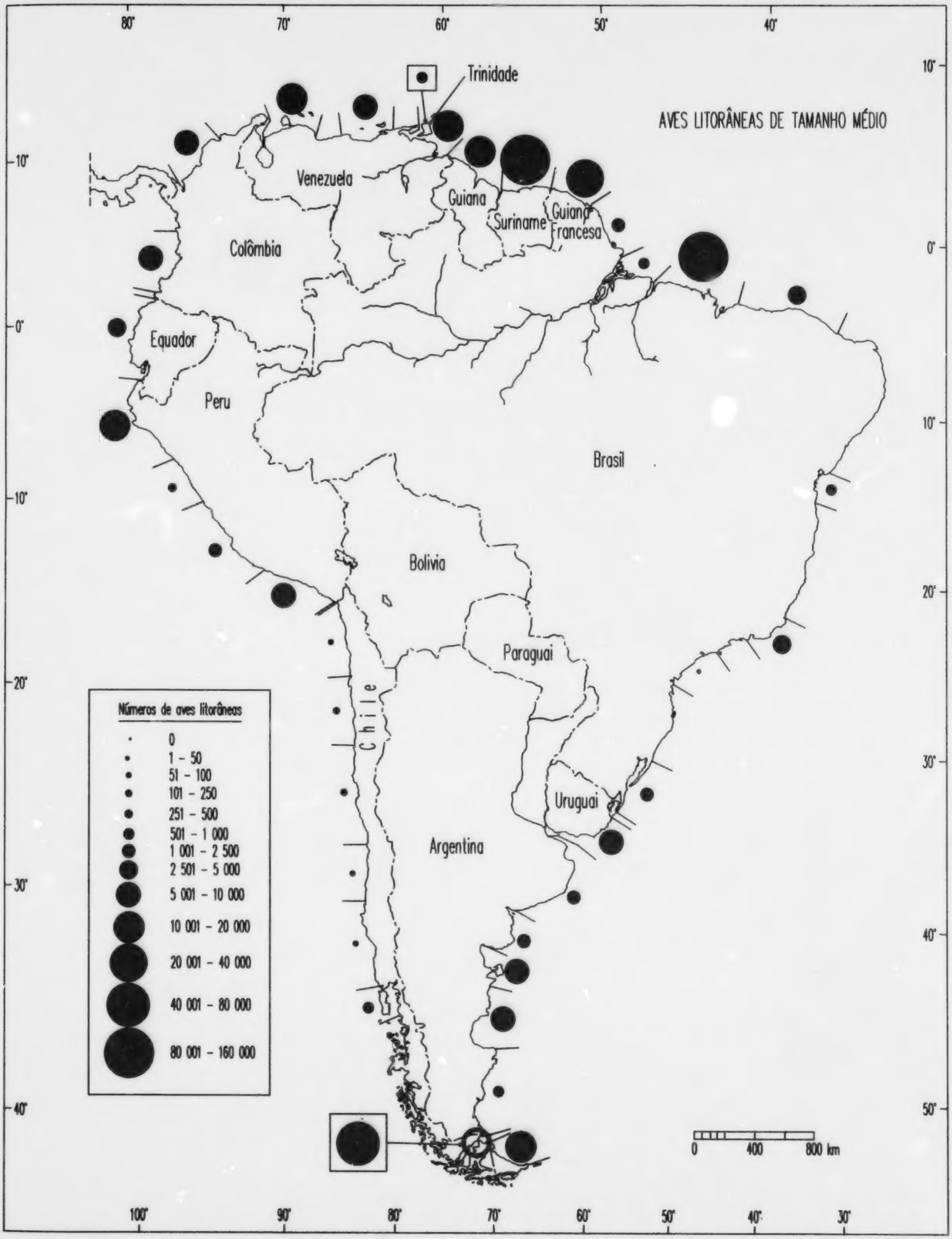
Mapa 3.1
Distribuição das aves litorâneas pequenas no litoral da América do Sul


AVES LITORÂNEAS PEQUENAS
Trinidade
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 50 000
50 001 - 100 000
100 001 - 200 000
200 001 - 500 000
> 500 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

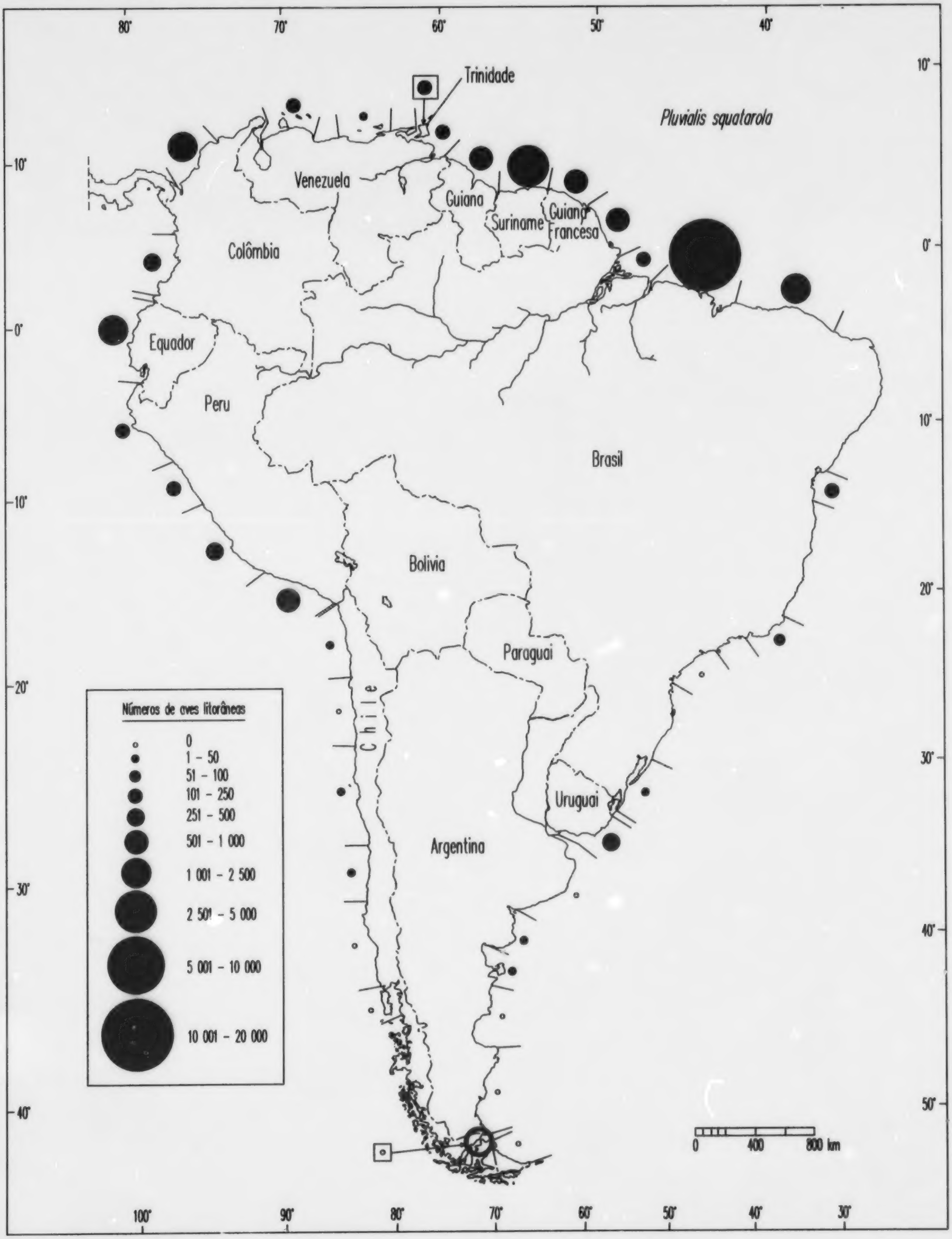
Mapa 3.2
Distribuição de *Calidris alba* no litoral da América do Sul


80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
Trinidade
Calidris alba
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolívia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.3
Distribuição das aves litorâneas de tamanho médio no litoral da América do Sul


AVES LITORÂNEAS DE TAMANHO MÉDIO
Trinidade
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
80 001 - 160 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.4
Distribuição de *Pluvialis squatarola* no litoral da América do Sul



Pluvialis squatarola
Trinidade
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
40°
30°

mente com arrecifes próximos, entre São Luís e o delta do rio Parnaíba.

No lado pacífico, as aves foram vistas principalmente no Peru, Equador e Colômbia, com alguns poucos indivíduos observados ao sul da fronteira Peru/Chile. O registro mais sulino (2 aves dessa classe de tamanho) dos censos estavam próximos ao rio Mataquito, na "eco-unidade" Valparaiso. No Peru, onde somente 1.300 aves foram encontradas (46,8% do total, da costa do Pacífico e 4,9% do continente), muitos *P. squatarola* estavam nos brejos bem esparsos da região costeira. No sul do país, as aves estavam nos ambientes aquáticos formados pela foz do rio Camana (235) e pela foz do rio Locumba (120), assim como na área das Lagunas de Mejia (110). Quáse tôdas as outras aves observadas no centro e norte do Peru eram vistas nêsse mesmo tipo de ambiente ou nas praias próximas (por exemplo rio de Huaura, Paramonga, Baía de Sechura). Um dos maiores bandos observados foram as 260 aves da Baía de Paracas, dentro da Reserva Nacional de mesmo nome.

No Equador, *P. squatarola* foi vista principalmente ao redor do Golfo de Guayaquil, a maioria na costa externa do golfo onde há uma mistura de baixios entre-marés e ambientes arenosos enquanto a parte interna é constituída por áreas lodosas e manguezais. Os melhores habitats estavam próximos à fronteira com o Peru na parte sudeste da Isla de Puna e a entrada noroeste da baía. A espécie era mais comum em habitats similares do sul da Colômbia entre Tumaco e Buenaventura.

Poucos *P. squatarola* (620 ou 2,3% do total do continente) foram anotados na metade sul da costa do Atlântico. Menos aves ainda apareceram nos setores da Argentina, algumas no estuário próximo à Bahia Blanca e na área costeira do estuário de San Antonio Oeste. A maior concentração estava na Laguna de Rocha, uma extensa laguna próxima ao litoral uruguaio. Números pouco expresivos estavam na costa ao norte do Rio de Janeiro, onde pequenas lagoas ocorrem justapostas ao litoral. O mesmo ocorreu na Baía de Todos os Santos, perto de Salvador, da mesma forma que algumos *P. squatarola* surgiram nos estuários delineádos por mangues entre Valença e Ituberá, ao sul de Salvador.

3.2.5. *Arenaria interpres*

Com grande distribuição ao longo da América do Sul, *A. interpres* foi observado em grupos pequenos até a Terra do Fogo. Entretanto, foram mais numerosos na costa norte e medianamente comuns nas praias pacíficas (Mapa 3.5). Do total de 23.500 *A. interpres*, 86,2% ocorreram na costa norte, com 10,0% na costa pacífica e somente 3,8% na costa atlântica.

O local mais importante foi o litoral entre Belém e São Luís, onde acima de 17.900 aves foram anotadas, representando 76,2% do total para a América do Sul e 88,5% do total regional. Essa costa, descrita sob *P. squatarola*, contém as coroas de lama preferencialmente utilizadas por *A. interpres*. Outras áreas destacadas foram o Suriname (2,6% e 3,1% do total sul-americano e regional, pela ordem) e Guiana Francesa (2,6% e 3,0%, na mesma sequência), assim como a costa nordestina do Brasil (1,8% e 2,1%). Enquanto nas Guianas as coroas de lama e praias foram muito utilizadas, no nordeste do Brasil eram usadas as praias oceânicas com arrecifes.

Na costa pacífica, a maioria das 2.400 aves estavam no Peru (81,1% do total regional e 8,1% do total do continente). As aves eram mais numerosas nos setores com praias arenosas ou de seixos, tendo próximas foz de rio, laguna, brejo ou áreas agrícolas próximas ao litoral. No Equador e Colômbia, *A. interpres* estavam geralmente nas costas com praias arenosas próximas a bancos de areia ou com grandes baixios inter-marés.

Densidades eram geralmente altas na costa do Brasil entre Belém e São Luís, com setores alcançando 10–20 aves/km em distância de 60 a 124 km, sendo o maior valor 31 aves/km. Nas Guianas, a área subsequente em importância, as densidades eram baixas, pouco excedendo 1 ave por quilómetro, sendo os valores extremos de 9 aves/km no Suriname e 13 aves/km na Guiana Francesa. Na costa pacífica, as densidades também foram baixas. No Peru, raramente excederam 1 ave/km, com o valor máximo de 12 aves/km ao longo das praias próximas ao Deserto de Sechura no norte do Perú.

3.2.6. *Tringa melanoleuca* e *T. flavipes*

Igualmente distribuidas ao longo de todo o continente (Mapa 3.6), estavam mais concentradas na América do Sul, sendo a principal área de invernada situada nas Guianas. Dada a dificuldade de separar as duas espécies maiores de *Tringa* a partir da aeronave, os seus totais estão combinados. De 91.000 *T. melanoleuca* e *T. flavipes* anotados, sua distribuição foi a seguinte: 90,7% na costa norte, 6,7% na costa atlântica e 2,6% na parte pacífica.

As principais áreas de invernada no litoral estavam nas Guianas. Nos três países dêsse setor estavam 78.000 aves ou 85,9% do total para o continente. Suriname foi a área principal com 72,8% do total sul-americano, Guiana com 7,5% e Guiana Francesa 5,6%. Ambas espécies eram particularmente comuns nas áreas com extensas coroas de lama inter-marés ou nas lagunas costeiras adjacentes, habitat muito abundante nas Guianas, em espécial no Suriname. Habitats similares no leste da Guiana e no oeste da Guiana Francesa foram também muito usados. Em outros pontos da costa norte, *T. flavipes* e *T. melanoleuca* ocorreram nas Lagunas Campuchano no oeste da Venezuela, Laguna Piritu e lagunas a oeste de Barcelona, no centro da Venezuela, assim como em Caroni Swamp, Trinidade.

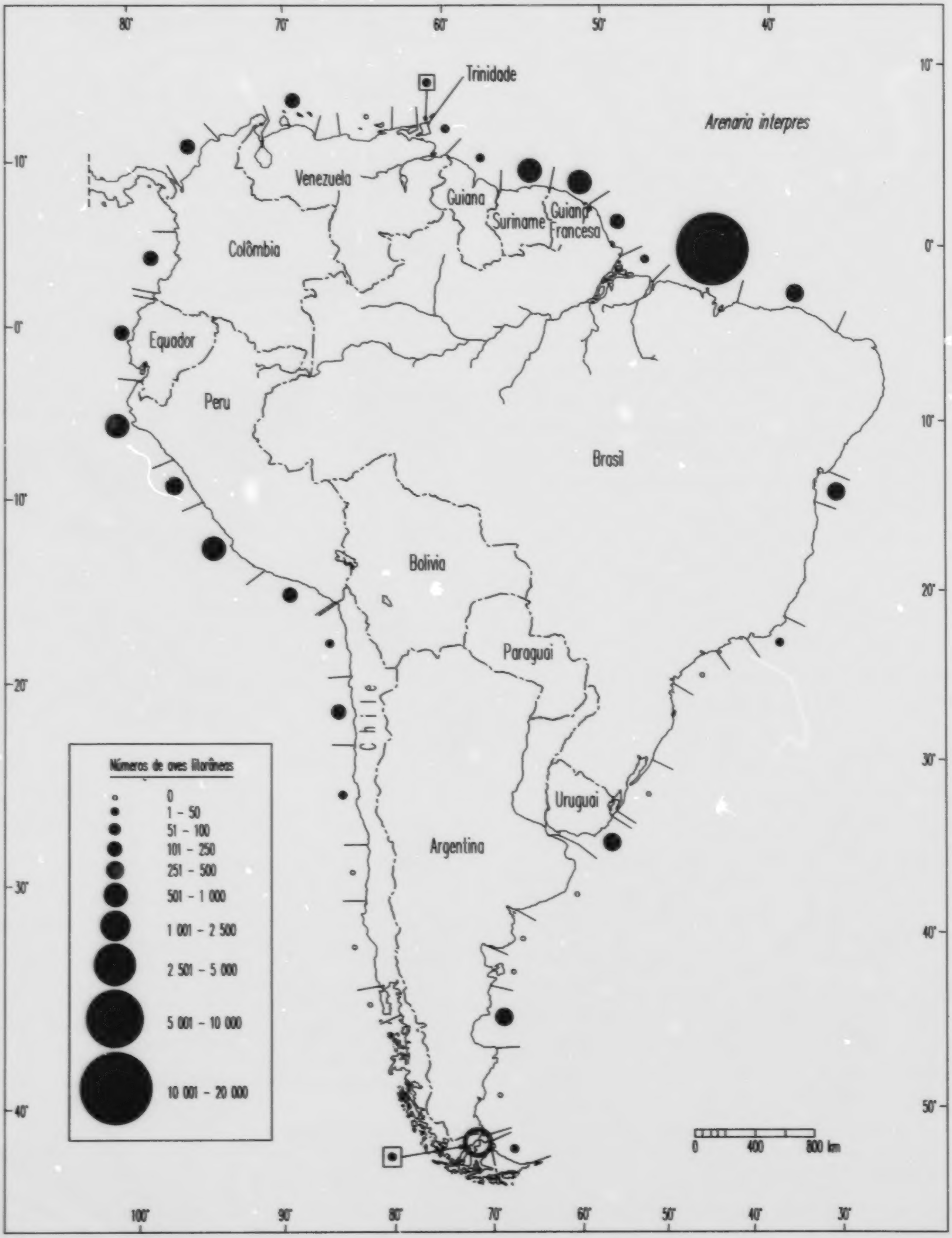
Na costa atlântica os maiores números surgiram das áreas alagadiças e rasas entre o Cabo de São Tomé e Atafona ao leste da Lagoa Feia na "eco-unidade" Rio no Brasil. Costas lacustres próximas ao litoral eram utilizadas no sul do Brasil, incluindo-se aí a Lagoa dos Patos e as pequenas lagoas associadas. Esse também é o caso da Laguna de Rocha no Uruguai e na costa da Província de Buenos Aires na Argentina (Laguna Mar Chiquita e Laguna Salada). Entretanto, nêste último país, as maiores concentrações estavam nos brejos costeiros da Bahia Samborombon.

Na costa oeste do continente as lagunas costeiras e brejos próximos à foz dos rios eram os mesmos habitats preferenciais. No Peru, por exemplo, os maiores números estavam nos brejos do Rio Camana (900), nas lagoas ao norte de Eten (450) e na área do Rio Pisco (340). Números relativamente altos ocorreram na Reserva de Paracas.

3.2.7. *Calidris canutus*

A maior área de invernada de *Calidris canutus* estava na Terra do Fogo e ao longo do litoral patagônico da Argentina (Mapa 3.7). Poucas concentrações ocorreram em outros locais; números baixos estavam na costa entre Belém e São Luís assim como no oeste da Venezuela.

Mapa 3.5
Distribuição de *Arenaria interpres* no litoral da América do Sul


Arenaria interpres
Trinidade
Venezuela
Colômbia
Guiana
Suriname
Guiana Francesa
Equador
Peru
Brasil
Bolívia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
80°
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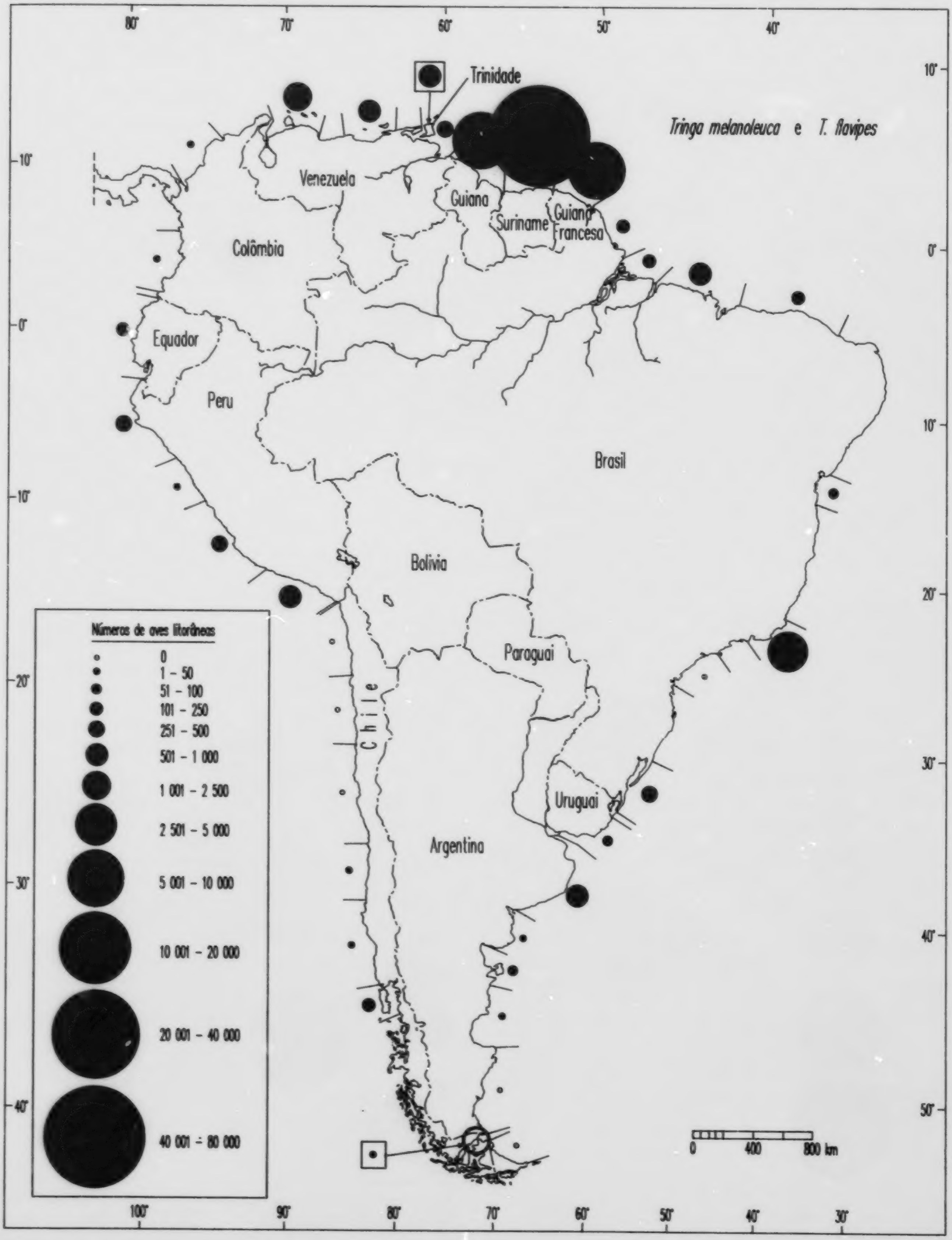
Mapa 3.6
Distribuição de *Tringa melanoleuca* e *T. flavipes* no litoral da América do Sul



Tringa melanoleuca e T. flavipes
Trinidade
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolívia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
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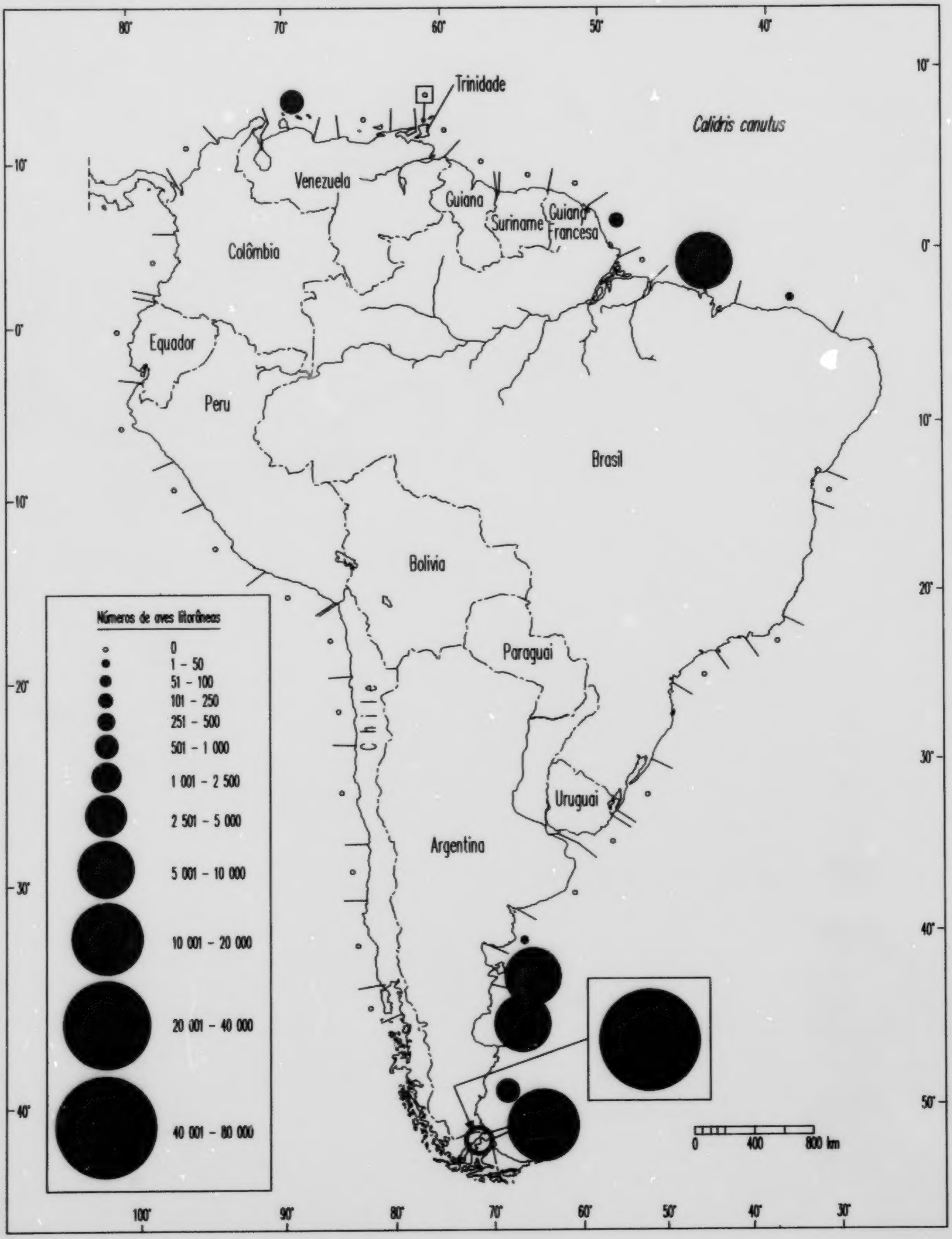
Mapa 3.7
Distribuição de *Calidris canutus* no litoral da América do Sul



80°
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Trinidade
Calidris canutus
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
0
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800 km
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40°
30°

Algumas observações esparsas foram anotadas em outros pontos da costa norte do Brasil.

O ponto mais importante descoberto para essa espécie foi, sem sombra de dúvida, a Bahia Lomas, situada na boca leste do Estreito de Magalhães no setor Chileno da Terra do Fogo. A baia contém uma vasta área de coroas de lama uniformes ou recortadas finalizadas por baixadas cobertas de gramíneas. No final de janeiro de 1985 estavam nessa área 41.700 *C. canutus* ou 54,6% do total sul-americano. Outras concentrações importantes foram 5.100 aves próximo o Rio Grande e 4.440 aves na região da Bahia San Sebastian na parte argentina da Terra do Fogo. *C. canutus* em Rio Grande alimentava-se em extensas áreas de "restinga" rochosa descobertas pela maré. Seu pouso preferido era Punta Popper ou a praia de Rio Grande. Aves da Bahia San Sebastian usavam as grandes coroas de lama recortadas por pequenos canais e uma longa drenagem paralela à costa. Somando-se todas as aves, o setor da Terra do Fogo abrigava cerca de 42.800 aves (ou 56,0% do total do continente) e o argentino cerca de 10.500 (ou 13,7%). Os dois valores combinados mostram que 69,7% dos *C. canutus* estavam na Terra do Fogo.

Outros grupos significativos estavam no Golfo San Jorge e Península Valdes, na Patagônia argentina. A "eco-unidade" Golfo San Jorge estava com 8.700 aves (ou 11,4% do total), com números altos na Bahia Bustamante (7.400) e ao longo da "restinga" ao sul de Comodoro Rivadávia entre Caleta Olívia e Cabo Blanco (1.300). A Península Valdes, outro local importante, continha mais de 5.000 *C. canutus* (ou 6,6% do total sulamericano). Os bandos foram vistos em vários locais da Península — 1.200 ao norte, próximo a Puerto Lobos na costa do Golfo San Matias, 1.000 próximo a Caleta Valdes, 2.000 na Punta Delgado e 300 e 500 na entrada do Golfo Nuevo. O Golfo San José na parte setentrional da área não foi sobrevoado por razões logísticas. A área é conhecida como importante local de parada de *C. canutus* durante a migração para o norte (Harrington, 1982; Morrison, 1984). Concentrações menores surgiram na parte meridional da costa patagônica, ao sul de Puerto Deseado junto à Punta Medanosa (400) e Cabo Danaso (150). Todos os 67.500 *C. canutus* do atlântico foram anotados entre a Terra do Fogo e o Rio Colorado (Argentina), representando 88,4% do total sulamericano da espécie.

Os restantes 11,6% foram vistos na parte norte do continente. A maioria apareceu na costa brasileira entre Belém e São Luís, onde 8.200 *C. canutus* (10,7% do total) surgiram em dois bandos com 5.000 e 3.000 aves, na área de São Luís. Como mencionado anteriormente, essa unidade é muito produtiva e abriga um grande número de espécies com populações altas, em especial aves litorâneas de porte médio e grande. A outra concentração notável foi anotada na foz de Lago Maracaibo próximo à costa do Golfo da Venezuela.

Nenhum *C. canutus* foi observado no lado pacífico do continente durante esse sobrevôo, embora pequenas concentrações já foram anotadas em trabalhos de campo na região (dados inéditos; por exemplo, Hughes, 1976).

3.2.8. *Limnodromus griseus* e *L. scolopaceus*

Embora não seja possível distingui-los especificamente do ar, poucos ou nenhuns *L. scolopaceus* devem alcançar a América do Sul (Blake, 1977). Dessa forma, as observações do sobrevôo devem ser relativas a *L. griseus*. De qualquer forma, as aves estavam claramente restritas ao norte do continente, onde 97,1% do total de 49.000 *Limnodromus* foram observados (Mapa 3.8). Os restantes 2,9% surgiram na costa pacífica, alcançando unicamente o Equador como limite sul. Nenhum foi observado ao sul desse país e a espécie não surgiu no restante da costa atlântica.

Os habitats preferenciais foram os manguezais com largas faixas inter-marés ou lagunas costeiras. As aves estiveram particularmente concentradas nesse tipo de habitat no Suriname com 44,7% do total sulamericano. Habitats semelhantes na Guiana e Guiana Francesa abrigavam 5,9% e 4,9%, respectivamente. A segunda concentração mais importante situava-se no litoral entre Belém e São Luís, onde 8.100 aves (16,6%) estavam nos baixios inter-marés dessa costa acidentada. As lagunas da costa central venezuelana como aquelas a oeste de Barcelona e, em especial, a Laguna Chacopata abrigavam números substanciais (7.100 aves ou 14,6%). Padrão similar foi visto em outros pontos, seja nos manguezais do Delta do Orinoco (3.100 ou 6,3%), lagunas da costa caribenha da Colômbia (1.600 ou 3,2%) e manguezais da costa pacífica colombiana (600 ou 1,2%) e equatoriana (830 ou 1,7%).

3.2.9. Aves litorâneas de grande porte

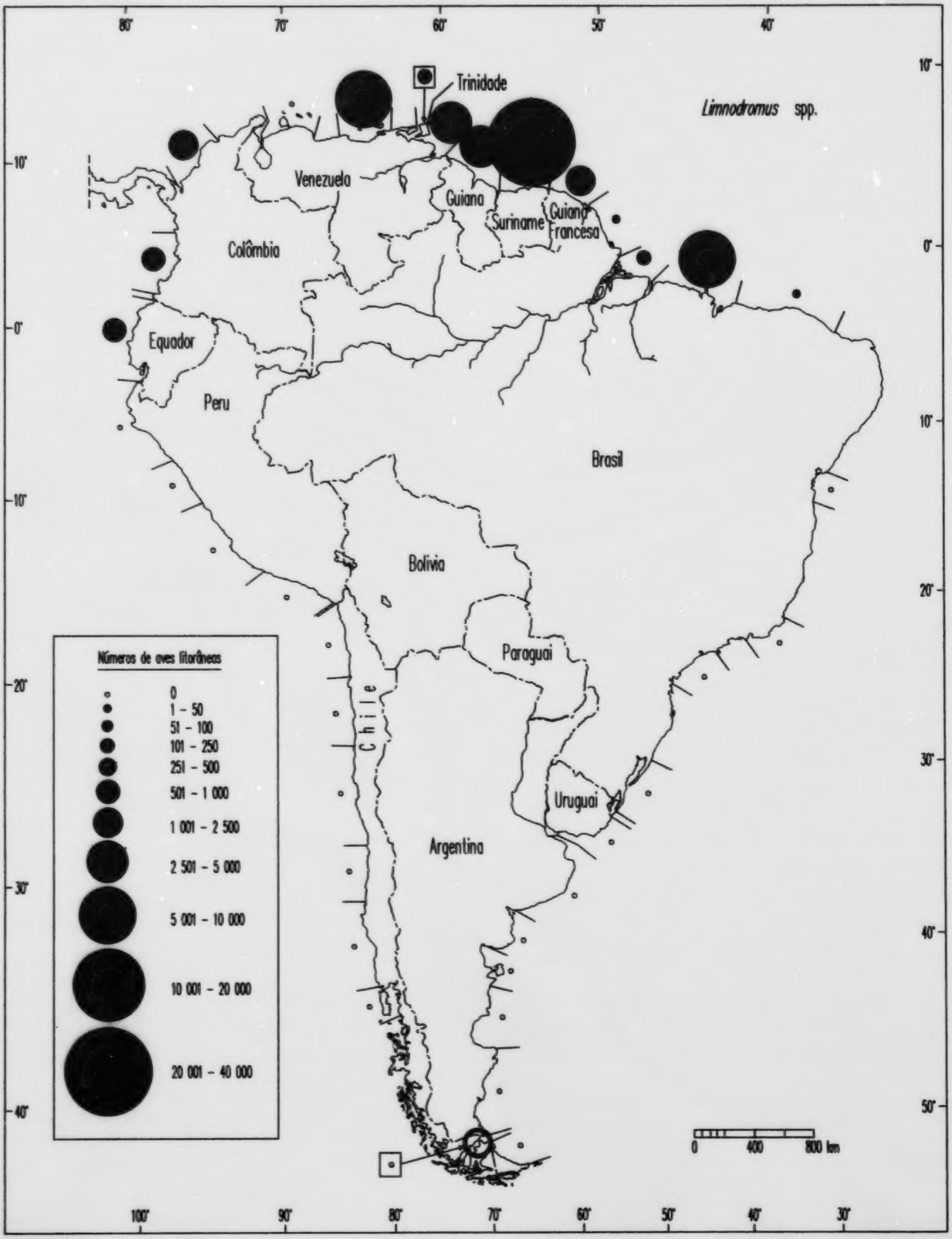
Acima de 121.000 aves dessa categoria de tamanho foram anotados nos sobrevôos, representando 4,2% do total geral de 2,9 milhões da América do Sul entre as classes de tamanho (Tabela 3.2). Vários centros de concentração surgiram: Suriname, costa entre Belém e São Luís no Brasil, na Terra do Fogo e Ilha Chiloé, no Chile. Tais pontos apresentam a tendência de refletir a distribuição de diferentes espécies (Mapa 3.9).

3.2.10. *Catoptrophorus semipalmatus*

A maior área de invernada dessa espécie foi a costa setentrional do continente, onde 89,3% do total de 44.400 foram vistos (Mapa 3.10). *Cataptrophorus semipalmatus* estavam associados com manguezais e coroas de lama. Tais habitats abundaram no litoral entre Belém e São Luís, a área de invernada mais importante da espécie, abrigando cerca da metade (49,3%) do total sulamericano. Suriname, onde tal habitat também é frequente, possuia 35,3% do total para o continente. No restante da costa norte estavam espalhados em pequenos números, com um pequeno ressalto junto à foz do Rio Amazonas. A distribuição dos manguezais efetiva a distribuição da espécie nas duas costas do continente, embora alguns indivíduos tenham chegado até o sul do Peru e norte do Chile. Na costa pacífica da Colômbia, *Catoptrophorus semipalmatus* estava nos manguezais (1,5%), particularmente entre a Bahia Buenaventura e a fronteira com o Equador. Nesse último país (3.400 ou 7,6%) estava em manguezais como os do Golfo de Guayaquil (1.900) ou mosaicos de praias com mangues tais como a Bahia de Caraquez (1.200). A maioria das aves observadas no Peru (590 ou 1,3%) estavam nos manguezais nortenhos (Tumbes, 22), complexos pantanosos (Sechura, 170) ou estuários (Virrila, 200). O restante surgiu nas longas praias oceânicas, normalmente junto a embocaduras ou brejos, até o norte do Chile.

Na costa atlântica, a espécie não foi notada ao sul de Salvador, onde poucos indivíduos (80 ou 0,2%) surgiram nos manguezais ou nos complexos de mangues e praias (Baía de Todos os Santos, Valença, Ituberá).

Mapa 3.8
Distribuição das batuíras do gênero *Limnodromus* no litoral da América do Sul


80°
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60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
Trinidade
Limnodromus spp.
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolívia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
100°
90°
80°
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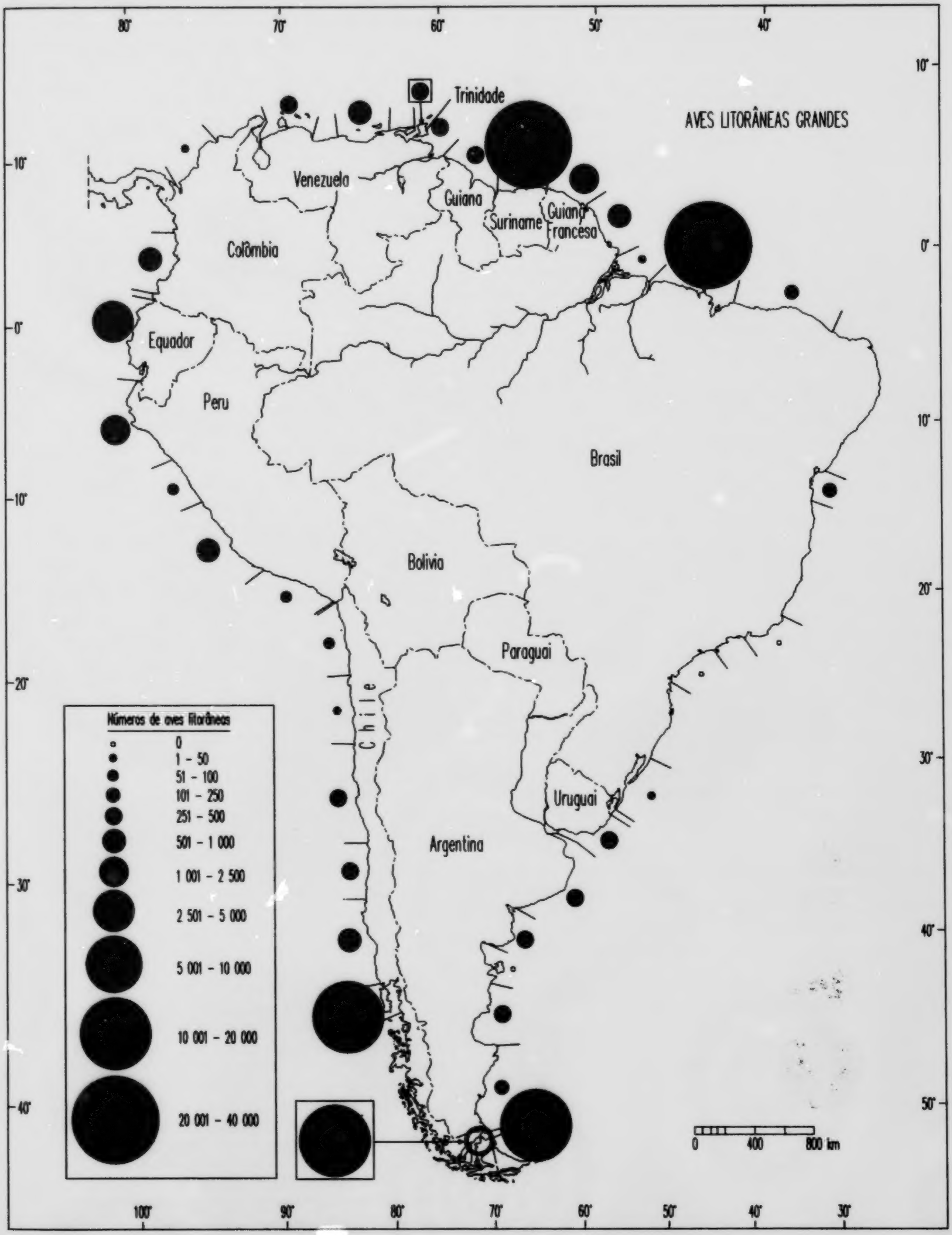
60°
50°
40°
30°

Mapa 3.9
Distribuição das aves litorâneas grandes no litoral da América do Sul


AVES LITORÂNEAS GRANDES
Trinidade
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
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400
800 km
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40°
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90°
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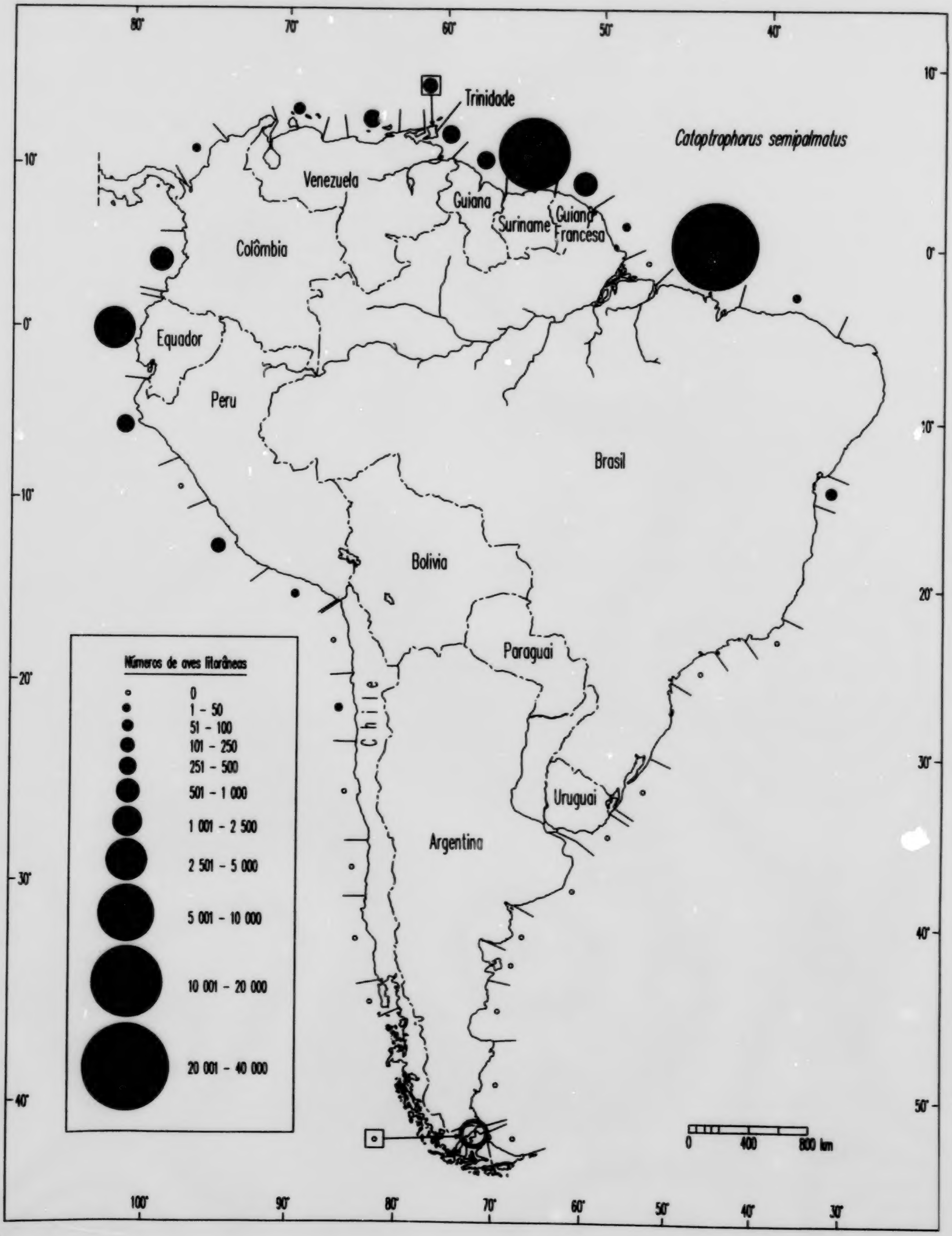
30°

Mapa 3.10
Distribuição de *Catoptrophorus semipalmatus* no litoral da América do Sul



80°
70°
60°
50°
40°
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0°
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20°
30°
40°
50°
Trinidade
Catoptrophorus semipalmatus
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
0
400
800 km
100°
90°
80°
70°
60°
50°
40°
30°

3.2.11. *Limosa haemastica*

A principal área de invernada no litoral foi a ponta sul do continente. Dois centros de distribuição evidenciavam-se; o mais importante foi a Terra do Fogo, embora a Ilha de Chiloé, Chile, também abrigasse bons números (Mapa 3.11). Do total de mais de 45.500 aves, 71,9% estavam no lado atlântico, contra 28,1% no pacífico.

A concentração mais importante de *Limosa haemastica* ocorreu na Terra do Fogo, cerca de 19.500 (42,8%) no lado argentino e em torno de 11.700 (25,6%) do lado chileno. O sítio de maior importância foi a Bahia San Sebastian, Argentina, no lado atlântico da Terra do Fogo, onde 19.400 ocupavam as enormes coroas de lama recortadas por canais e protegidas pela longa (18 km) Península El Paramo. Somente ali estavam cerca de 42,5% do total do continente, tornando a área de enorme importância internacional. O restante das aves estavam nas "restingas" do resto da Terra do Fogo argentino. O segundo local em importância foi a Bahia Lomas (o melhor local para *Calidris canutus*), situada a 60 km ao norte da entrada atlântica do Estreito de Magalhães. Os baixios acidentados abrigavam 10.500 aves (23,1%). As aves restantes (1.140) da Terra do Fogo chilena foram encontradas após a boca da Bahia Lomas na costa setentrional do Estreito de Magalhães.

Números baixos apareceram esparsamente ao longo da costa atlântica até o Uruguai. Nas áreas meridionais, ao longo da Patagônia, a maioria estava nas "restingas", como em Puerto Deseado (160) e ao longo da Caleta Olivia (350) ao sul de Comodoro Rivadavia. Já na porção norte da Argentina, *Limosa haemastica* foi observada tanto nas áreas estuarinas como nos extensos baixios da Bahia Union e Bahia Anegada (310) ao sul da foz do Rio Colorado, bem como nos baixios da parte sul da Bahia Samborombon (430) a oeste da Punta Rasa na Província de Buenos Aires. No Uruguai as aves estavam principalmente nas lagunas salobras e de agua doce, como a Laguna de Rocha (215), Laguna de Castillos (50) e Lagoa Mirim (60). Embora essa ave também use ambientes lacustres do interior da Província de Buenos Aires e Uruguai (Myers e Myers, 1979) as principais áreas de invernada identificadas durante os sobrevôos estavam no litoral sul do continente.

Áreas importantes também surgiram na região da Ilha Chiloé, com mais de 12.600 aves (27,8% do total sulamericano) de cerca de 12.800 para a costa pacífica. A maioria das aves ocorreram na Ilha Chiloé, em especial nas áreas em frente ao Golfo de Ancud, onde os totais para os setores variaram de 250 a 2.000 aves. Números grandes (2.900) estavam nas áreas similares a oeste de Puerto Montt e no grande delta a leste de Puerto Montt na costa norte do Golfo de Ancud. Embora muitas dessas áreas sejam escarpadas, frequentemente surgem deltas pantanosos ou outros tipos de habitats aquáticos, tipos de áreas onde a maioria das *Limosa haemastica* foram observadas.

Os registros eram mais esparsos no restante, sendo o mais no tável as 170 aves da região do Rio Pisco no centro-sul da costa peruana.

A migração de *Limosa haemastica* é uma das mais espetaculares do mundo. Na década de 40 a espécie estava listada como em risco de extinção devido ao baixo número que então era anotado (e ainda o é) para a costa leste norte-americana. Das áreas de reprodução no centro do Ártico canadense, a espécie concentra-se em grandes números para a migração, como na Baia de Hudson e James, fenômeno já notado pelos primeiros orniólogos (Hope e Shortt, 1944) e posteriormente confirmado por extensos sobrevôos (Morrison e Harrington, 1979; Morrison 1983, 1984), os quais localizaram concentrações de até 10.000 aves em um único ponto. Da Baía de James as aves voam diretamente para a América do Sul (Hagar, 1966). O próximo local com grandes números é a Província de Buenos Aires na Argentina, embora o calendário de migração sugira a existência de um desconhecido ponto de parada intermediária na parte norte da América do Sul (Morrison, 1984). Aparentemente, as populações atingindo a Terra do Fogo tem origem nas regiões árticas do centro do Canadá. A origem das populações da área de Chiloé e como migram é um ponto a ser futuramente conhecido, talvez tendo como irigem no oeste do Ártico canadense e Alaska.

3.2.12. *Numenius phaeopus*

Embora distribuídos ao longo da América do Sul, três áreas principais de concentração ressaltaram-se a partir dos sobrevôos : a costa entre Belém e São Luís, Suriname e Ilha Chiloé no Chile (Mapa 3.12). A maioria das aves (61,3%) do total geral de 24.900 *Numenius phaeopus* ocorreram na parte setentrional do continente com números importantes (37,8%) na costa pacífica e poucos (0,8%) no lado atlântico.

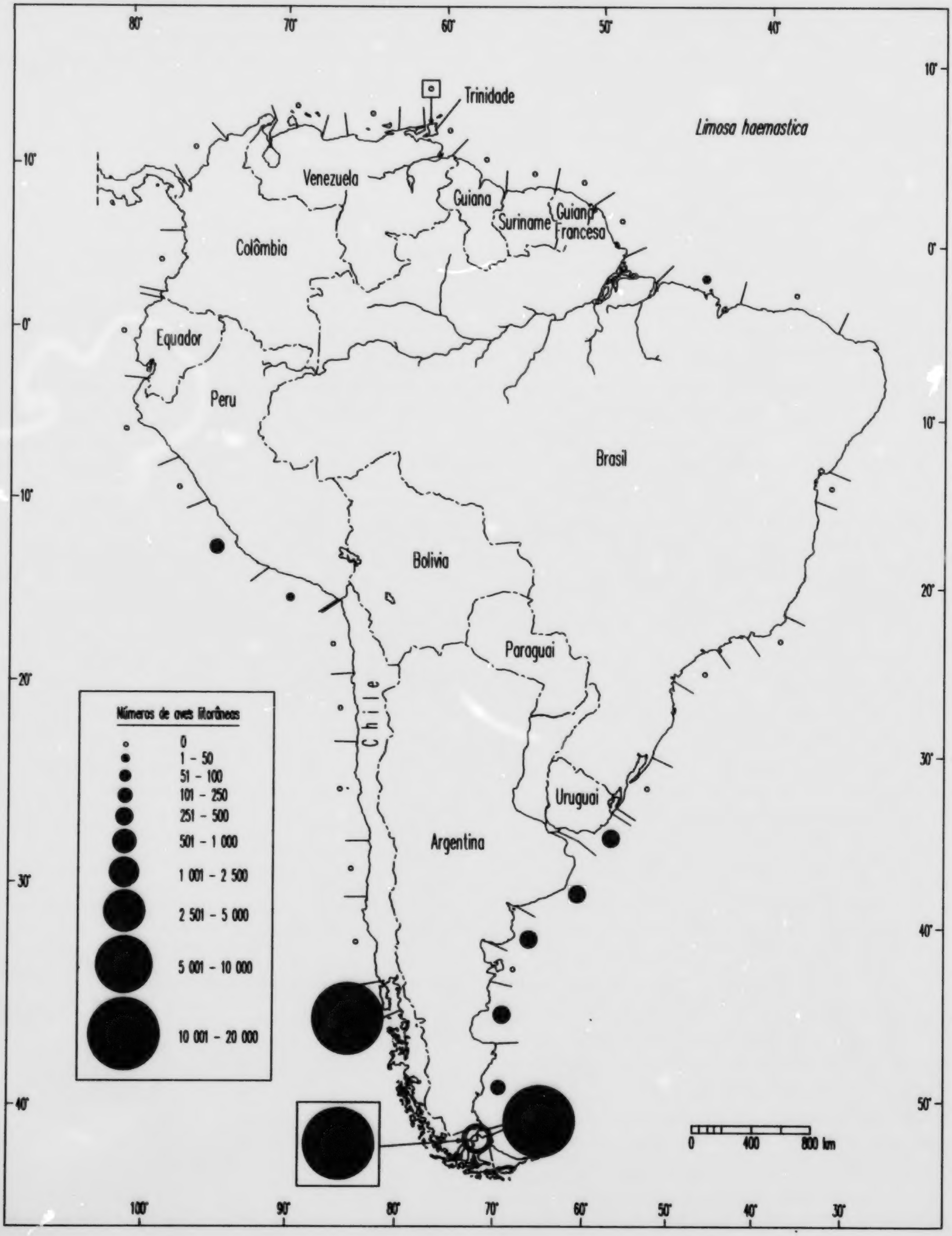
Na costa norte, *Numenius phaeopus* esteve associado com áreas de extensos baixios inter-marés e manguezais, especialmente nas áreas com coroa de lama. Tais habitats foram frequentes na costa entre Belém e São Luís, a qual abrigou 43,7% do total sulamericano (71,3% do total da costa setentrional), assim como no Suriname (13,3% do total do continente). Já nos outros pontos dessa costa com o mesmo tipo de habitat os números foram muito baixos.

No lado pacífico, os maiores números estavam na região da Ilha Chiloé (6.200 ou 25,0% do total sulamericano). A espécie estava bem distribuída ao longo das costas norte e leste da Ilha Chiloé, nas ilhotas em frente ao Golfo de Ancud — totais de setores variando de 30 a cerca de 700 aves, para um total geral de 2.800 aves. Muitas dessas ilhotas continham deltas pantanosos ou brejos logo após a costa, as vezes com coroas de lama associados. Esses eram os habitats usados por *Numenius phaeopus*. A maior concentração nessas ilhotas foi vista a oeste de Puerto Montt, abrigando 1.100 aves e mais 740 foram localizadas em um extenso complexo estuárino próximo a Maullin.

No restante do litoral pacífico, *Numenius phaeopus* surgia em pequenos números e usando grande variedade de habitats, em especial as praias oceânicas do Chile setentrional e Peru (930 aves ou 3,8%). No Equador (560 aves ou 2,3%) e na costa pacífica da Colômbia (320 aves ou 1,3%), a espécie era novamente comum nos manguezais com coroas de lama, particularmente ao longo da costa leste do Golfo de Guayaquil e o litoral colombiano desde a fronteira com o Equador até a Baía Buenaventura.

Os pequenos números da costa atlântica estavam nos manguezais da região de Salvador, no Brasil, e nas baías e ilhotas do Estreito de Magalhães, no Chile.

Mapa 3.11
Distribuição de *Limosa haemastica* no litoral da América do Sul



80°
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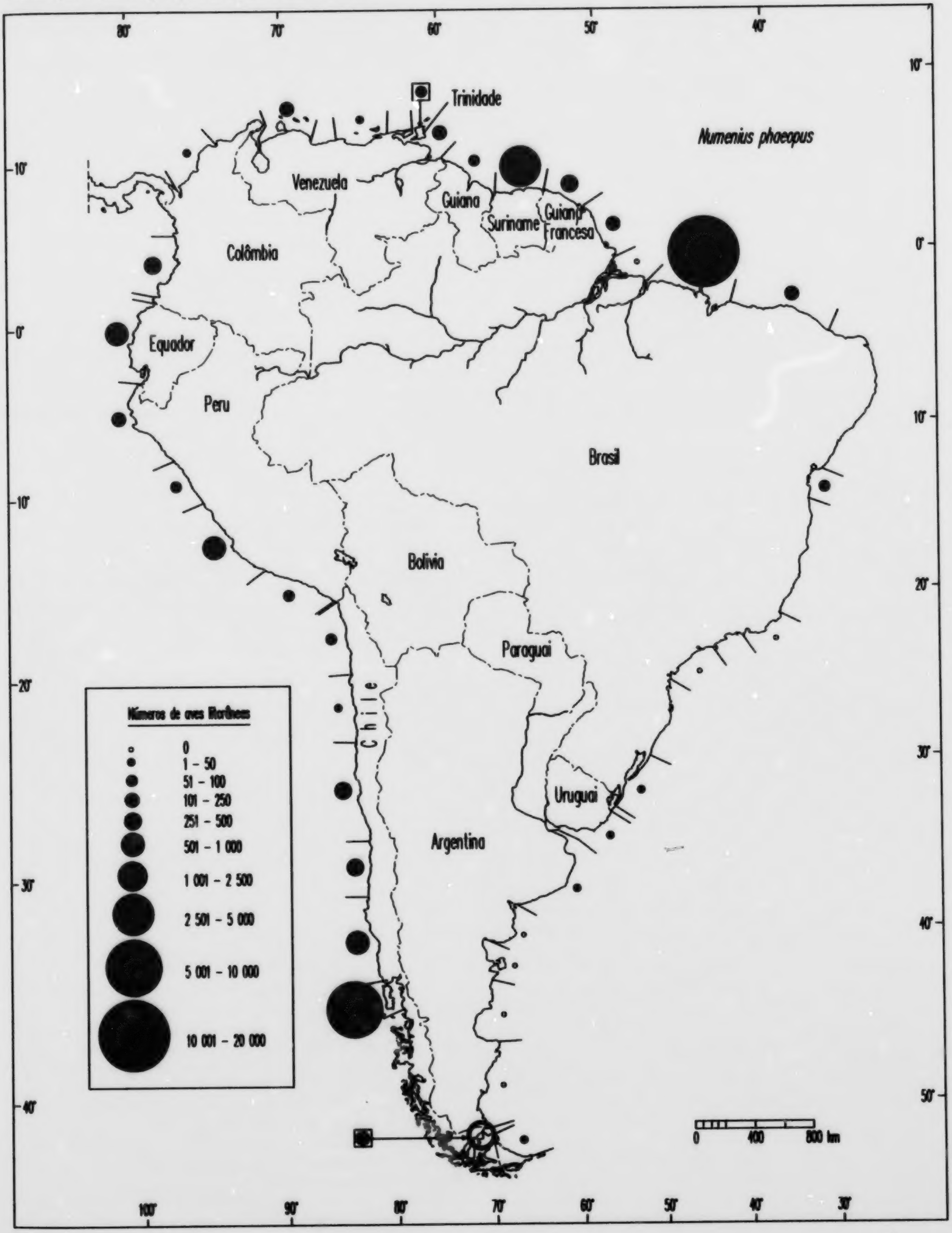
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
Trinidade
Limosa haemastica
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
Peru
Brasil
Bolivia
Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0
400
800 km
100°
90°
80°
70°
60°
50°
40°
30°

Mapa 3.12
Distribuição de *Numenius phaeopus* no litoral da América do Sul


Numenius phaeopus
Trinidade
Venezuela
Guiana
Suriname
Guiana Francesa
Colômbia
Equador
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Paraguai
Chile
Uruguai
Argentina
Números de aves litorâneas
0
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51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
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40°
30°
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10°
20°
30°
40°

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Chapter 4

Shorebird distribution and coastal environments in South America

R.I.G. Morrison and R.K. Ross

4.1. Environmental factors affecting the distribution of Nearctic shorebirds

Results from the South American Shorebird Atlas Project have clearly identified many of the principal wintering areas used by a variety of shorebird species on the coast of South America. The broad geographical scale of the project has provided a unique continental perspective on shorebird distribution. Although some important areas are shared by different species, many species have a characteristic distribution pattern that distinguishes them from the others. What are the reasons for the observed patterns? Little detailed information is available on food and other resources required by shorebirds over such a large geographical range; however, the location of major wintering areas is related both to the large-scale geomorphological structures of the coastlines of South America and to environmental influences, such as climate, nutrient input, and oceanographic conditions, which presumably combine to make such areas particularly biologically productive (Fig. 4.1).

The north coast of South America was by far the most important area for numbers of small shorebirds, with Suriname and French Guiana supporting some 65 and 19%, respectively, or together some 84%, of the regional North Coast total of 2.1 million. The importance of the coast of the Guianas is related to the presence of very extensive mudflats, the sediments of which are derived from those discharged from the Amazon River. The bulk of sediments carried to the sea by the vast Amazon system originate in the Andes mountains; after discharge into the Atlantic, the sediments are carried northwestwards by the Guiana Current and are deposited along the northern coast of South America, especially along the coast of the Guianas. The currents and tides produce a very dynamic coastal system, with mudflats steadily migrating westwards along the coast, leading to an alternating pattern of sandy beaches and intertidal flats. Despite the unstable sediments, heavy currents, and high turbidity of the water, the vast intertidal areas are productive enough to be able to support enormous populations of shorebirds. In Suriname, Swennen *et al.* (1982) showed that a zone with a high density of crustaceans (mainly tanaid shrimps) occurred on the upper part of the flats below mean high-tide level, with much lower densities of invertebrates occurring at lower tidal levels where immersion times were longer. In general, very little information is available on benthic intertidal invertebrates in South America, and the study by Swennen *et al.* (1982) is one of the only published accounts available on potential food resources of shorebirds.

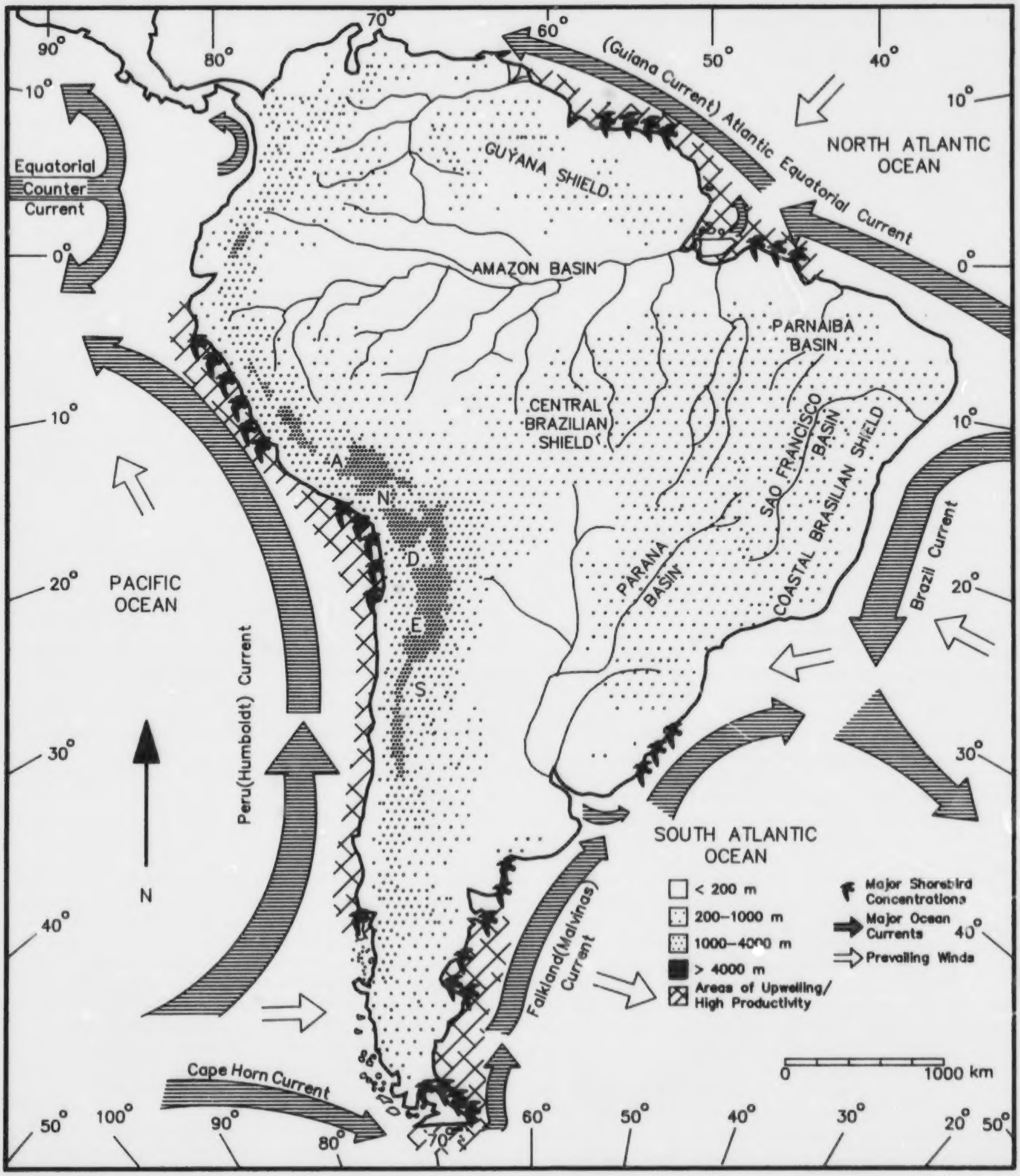
Extensive mangrove forests occur along the coasts of the Guianas. In addition to lateral migration of mudflats, cycles of progradation and erosion of the shoreline occur, so that areas of open swamps and lagoons may develop where mangrove forests have died out, providing further near-coastal habitats for shorebirds. Sediment deposition appears to be particularly extensive along the coasts of Suriname and French Guiana, which occupy an indentation in the Guiana Shield. Farther east, intertidal sediments tend to become sandier, i.e., coarser, and large sandflats are found around the mouth of the Amazon. Water discharge is so high in this area that the environment is essentially freshwater. Currents are also very strong, possibly precluding the development of an abundant intertidal fauna, which may explain the rather low numbers of shorebirds found in the mouth of the Amazon itself.

The coastline to the east of the Amazon, between Belem and Sao Luis, is also very important for shorebirds, and certainly one of the most impressive and unique sectors of habitat for birds in South America (Morrison *et al.* 1986*a*, 1986*b*, 1987). The area is especially significant for Ruddy Turnstones and supports important concentrations of Whimbrels, Black-bellied Plovers, Willets, dowitchers, and small shorebirds. The coast is made up of a series of drowned river valleys, leading to the formation of the present highly indented shoreline, in contrast to most of the rest of the north coast of the continent, which is relatively straight. The result is a series of broad, shallow bays, separated by headlands with sandy outer shorelines. Incoming sediments mostly remain trapped within each bay, so that the inner recesses contain extensive soft, intertidal flats. There is thus a gradation in sediments from fine to coarse from the inner parts of the bays to the outer, sandier sections, producing a wide range of habitats that support a diversity of shorebirds. Very broad stands of mangroves develop around the inner margins of the bays, in some cases stretching across the headlands from one bay to the next, forming what is probably the most extensive mangrove forests in South America; primary productivity is presumably very high in these areas.

One of the surprises of the surveys was the rather small numbers of shorebirds found along the ocean beaches and mangrove estuaries of northeastern Brazil, for instance around Salvador, despite the presence of suitable-looking habitat for shorebirds. It is not known whether these areas are unproductive or produce the wrong types or size classes of food resources for shorebirds.

There was a similar lack of major concentrations of small shorebirds on the tropical and subtropical estuaries on the Pacific coast of South America, such as the man-

Figure 4.1
Some of the main geographical features of South America


(Guiana Current) Atlantic Equatorial Current
NORTH ATLANTIC OCEAN
Equatorial Counter Current
GUYANA SHIELD
AMAZON BASIN
PARNAIBA BASIN
CENTRAL BRAZILIAN SHIELD
SAO FRANCISCO BASIN
COASTAL BRASILIAN SHIELD
PARANA BASIN
A
N
D
E
S
PACIFIC OCEAN
Peru(Humboldt) Current
Brazil Current
N
SOUTH ATLANTIC OCEAN
Falkland(Malvinas) Current
Cape Horn Current
< 200 m
200–1000 m
1000–4000 m
> 4000 m
Areas of Upwelling/ High Productivity
Major Shorebird Concentrations
Major Ocean Currents
Prevailing Winds
0
1000 km
90°
80°
70°
60°
50°
40°
10°
0°
10°
20°
30°
40°
50°
100°
90°
80°
70°
60°
50°
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30°
20°
50°

grove coastlines of southern Colombia, or around the Gulf of Guayaquil in Ecuador, despite the presence of extensive intertidal flats. These areas appear to be much more important during migration periods. Again, no information is available on the food resources and ecological factors that might determine the extent to which shorebirds could use such areas.

Farther south on the Atlantic coast of Brazil, few shorebirds were seen along the shorelines of the states of Rio de Janeiro or Sao Paulo, and it was not until the southern part of the country that significant wintering populations were found. The long ocean beaches of Rio Grande do Sul were especially important for Sanderlings wintering on the Atlantic coast, and the series of nearshore, shallow lagoons in Rio Grande do Sul and along the coast of Uruguay also supported large numbers of shorebirds, especially small sandpipers, principally White-rumped Sandpipers, and Lesser Golden-Plovers *Pluvialis dominica*. Not all the lagoons appeared suitable for shorebirds, the most heavily used being those that were both shallow and periodically connected to the sea, resulting in a saline or brackish regime. Particularly notable lagoons included the Lagoa do Peixe in southern Brazil and the Laguna de Rocha in Uruguay. The Lagoa do Peixe is also of major importance for shorebirds during migration, harbouring internationally important concentrations of Red Knots and Hudsonian Godwits (unpubl. results; Harrington *et al.* 1986). The combination of cool ocean currents flowing north along the coast and the geomorphological formation of a flat, sandy coastline with shallow nearshore lagoons appears to have resulted in particularly productive conditions for shorebirds (Fig. 4.1).

In Argentina, extensive intertidal areas occurred in Bahia Samborombon, Bahia Blanca, and the vast Bahia Union/Bahia Anegada; only moderate concentrations of shorebirds were found in these areas, although survey conditions were not ideal (low tide), and further coverage would be worthwhile. Nevertheless, the most important coastal wintering areas appeared to be farther south. Significant concentrations of Red Knots were found around the Peninsula Valdes, near Bahia Bustamante, and on the *restingas* in the southern part of Golfo San Jorge; the latter habitat, consisting of rocky, intertidal, wave-cut platforms supporting abundant invertebrate populations, comprises an important coastal wintering habitat for shorebirds. No studies have been carried out on the availability of the invertebrates on the *restingas* as a food resource for shorebirds. The large tidal ranges and cool, rich ocean currents occurring along the coast presumably encourage high productivity.

The most important wintering areas in the southern continent were found in Tierra del Fuego. Two bays in particular, Bahia San Sebastian on the Atlantic coast of Tierra del Fuego in Argentina and Bahia Lomas near the eastern mouth of the Strait of Magellan in Chile, are of outstanding international importance for Hudsonian Godwits and Red Knots. Both bays contain vast areas of intertidal flats, which have built up behind a long (18 km) gravel spit in Bahia San Sebastian and in a wide, semicircular indentation in the coast in Bahia Lomas. The *restingas* of the Atlantic coast of Tierra del Fuego were also an important habitat, supporting significant concentrations of Red Knots and White-rumped Sandpipers.

The coastlines of Tierra del Fuego are washed by cool currents rich in nutrients and have high tidal ranges. Where conditions are suitable for sediment deposition, as at Bahia San Sebastian and Bahia Lomas, or where a suitable intertidal substrate is found, as with the *restingas*, the productive conditions have apparently led to the development of an intertidal zone with an invertebrate fauna capable of supporting large numbers of shorebirds. Suitable roosting areas are generally available close to the feeding grounds and are subject to little disturbance.

The morphology of the Pacific coast and the oceanographic, climatic, and other environmental conditions to which it is subjected differ from those of the rest of the continent (Fig. 4.1). The wintering shorebird populations are also distinct.

In the south, the fjord region of southern Chile consists of mountainous terrain with restricted intertidal areas, and little shorebird habitat is available. For these and logistical reasons, the fjord habitats were not surveyed.

The geological plate tectonic processes producing the Pacific coast have led to the formation of a very long and relatively straight coastline in Chile and Peru, behind which lie the massive mountain ranges of the Andes. The resulting shoreline is generally steep, with only a restricted coastal plain. In addition, no major drainage basins reach the coast, in contrast to the north (Amazon Basin) and Atlantic (Parana Basin) coasts of the continent. These factors, and the very arid climate of most of the coast of Peru and Chile, result in little input of sediment from terrigenous sources. The northward flow of the Peru (Humboldt) Current leads to a very productive marine and coastal environment, and the prevailing southwesterly winds and ocean swell result in the accumulation of sandy sediments along the shore, so that extensive ocean beaches form the characteristic habitat of the coasts of Chile and Peru. Farther north, extensive intertidal sediment accumulations are found in tropical habitats in the Gulf of Guayaquil in southern Ecuador and the mangrove coastlines of southern Colombia.

It is not surprising, therefore, that most of the Sanderlings found in South America occurred on the ocean beaches of the Pacific coast: some 88% of the total of 112 000. Peru and Chile together held 99% of the Sanderlings on the Pacific coast. Many of the major concentrations were found either near river mouths or coastal lagoons, or on long desert coastlines, in areas where the prevailing oceanographic conditions were particularly productive, to judge from the presence not only of Sanderlings, but of other birds, as well as fishermen.

The Chiloe area in southern Chile was very important for several species of shorebirds, particularly Hudsonian Godwits, Whimbrels, and Sanderlings. The productive oceanographic conditions, combined with the moderately hilly topography and associated sheltered inlets around the eastern coasts of Chiloe Island and the northern parts of the Golfo de Ancud, apparently provide a combination of adequate food resources and nearby roosting areas, although again no information is available on the food resources themselves.

Other habitats of special concern on the Pacific coast of South America are the isolated wetlands, often associated with river mouths, on the coast of Peru. Many rivers have seasonal flow patterns, which are dependent on rainfall or snowmelt in the Andes. Where sediment input is adequate, blunt deltas may be formed under the influence of the prevailing onshore winds and ocean swell, leading to the development of coastal lagoons between the resulting barrier ridges, as at the Mejia Lagoons near the mouth of the Rio Tambo and at the Rio Camana. In other areas, where river outflow is low or where discharge is through a deep gorge, estuarine development may be limited. Areas where lagoons have formed held modest, but regionally significant, numbers of small and medium-sized shorebirds. Their major significance for shorebirds, however, may well be as staging areas. The Mejia Lagoons and other wetlands near river mouths, as well as areas such as the intertidal flats of Bahia de Paracas and associated habitats towards the mouth of the Rio Pisco, reportedly support very large numbers of shorebirds during migration periods. The geomorphology of the Pacific coast has thus resulted in isolated patches of habitat separated from one another by large distances.

It is clear, then, that the major wintering areas used by shorebirds on the coast of South America occur where geomorphological processes have led to the occurrence of suitable substrates and where environmental factors produce food resources capable of supporting substantial numbers of shorebirds. Although the broad picture is clear, almost no quantitative information is currently available on the structure of the habitats or the food resources present. Further research is needed to show why particular areas are important. What are the food resources available to the birds, and what is the seasonal availability of such resources? How critical are other factors, such as the presence of secure roosting areas? Could birds turn to alternative areas if currently used sites became unavailable? What, indeed, is the availability of alternative sites? To what extent does competition for resources with shorebirds or other organisms determine distribution patterns?

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Chapter 5

International conservation of shorebirds

R.I.G. Morrison and R.K. Ross

5.1. The need for international conservation

Shorebirds are one of the most highly migratory groups of birds — and thus one of the most internationally shared — in the New World. Shorebirds have special conservation requirements owing to their long-distance migrations and a number of aspects of their natural history (see Section 5.4). To be able to complete their migrations between northern nesting areas, which provide the habitats, food, and other resources required for reproduction, and southern wintering grounds, where climate and food are suitable for subsistence but not for breeding, shorebirds depend on a chain of sites where they can feed intensively and accumulate the fat reserves that will provide the energy for the next stage of the journey. Flights between stopover areas are often over ecological barriers such as oceans, forests, or deserts, where the birds would be unable to land and feed, so that the ability to accumulate energy reserves at staging grounds is essential to the survival of the birds. Each stopover area thus forms an essential link in a chain of sites stretching from the breeding grounds to the wintering areas. Removal of one link in this chain has the potential to disrupt the entire migration system. Conservational planning and action must therefore be approached on an international level if they are to be ultimately successful, since massive mobilization of political and financial effort in one region may be of little use if critically important areas are lost in a remote but equally important part of the range.

5.2. International shorebird research

Until recently, little was known either about the distribution of shorebirds on an international scale or about the details of their migration patterns. Only within the last 10–15 years have research programs been undertaken to gather integrated information on shorebird populations in the New World throughout their migration ranges (see reviews by Morrison 1984; Morrison and Myers 1987). The South American Shorebird Atlas Project has formed one of the major elements in the program of international research on shorebird distribution and has led to the clear identification of principal wintering areas used by shorebirds on the coast of South America. Other major survey projects in North and South America have included the International Shorebird Survey project, involving volunteer survey networks providing information in eastern Canada and the United States, organized by the Canadian Wildlife Service in Canada and the Manomet Bird Observatory, Massachusetts, in the United States, as well as aerial and ground surveys carried out in James Bay, Hudson Bay, and the St. Lawrence estuary by the Canadian Wildlife Service. Other work has included the California Shorebird Survey (Jurek 1974), providing distributional information from the west coast of North America, and research in Alaska (Morrison and Myers 1987), providing information on habitat use during and after the breeding season in the western Arctic. Banding and migration studies have come from a number of sources, including large-scale studies in James Bay by the Canadian Wildlife Service (Morrison 1984), in eastern Canada/Gulf of St. Lawrence by McNeil and Burton (1973), in the mid-western United States by Martinez (1979) and Lank (1979), and in Suriname by Spaans (1979). The Manomet Bird Observatory has carried out extensive migration studies of the Red Knot (and other species) in Massachusetts, Florida, and various parts of South America (Harrington 1982). Recently, the Pan American Shorebird Program has coordinated banding projects on Sanderlings and other species in North and South America (Myers *et al.* 1984).

5.3. Conservational concerns

Shorebird populations face threats from a number of sources, both industrial and recreational, including hunting, disturbance, environmental contamination, and habitat loss and degradation (Senner and Howe 1984).

In North America, legislative protection of shorebirds from hunting is considered to have been an important factor in enabling many species to recover from severe declines brought about by excessive sport and market hunting early this century (Morrison and Harrington 1979; Senner and Howe 1984). Shorebird populations remain potentially vulnerable to hunting, and the North American experience underlines the need for effective legislative protection of the birds themselves as well as of the sites on which they depend (see Section 5.4). The extent to which hunting of shorebirds occurs in South America and the Caribbean is largely undocumented; although not apparently widespread, hunting for sport or food may be significant in some areas (Senner and Howe 1984).

The effects of pollution and environmental contamination are also largely undocumented. Oil spills near major shorebird sites would be capable of seriously affecting shorebird populations. The effects of rapid release of toxic chemicals from fat stores metabolized during long-distance migration are also unknown. Climatic changes resulting from the activities of mankind may also have a future impact on shorebird populations.

For shorebirds, whose migrations take them from almost one end of the hemisphere to the other, there are legitimate concerns that developments in various parts of their ranges may place populations at risk. In the Arctic, resource developments threaten habitats over wide ranges, although whether such developments are capable of more than a local impact is currently unknown, if only because identification of critical nesting areas has yet to be completed. There is no doubt that actual or proposed developments in other parts of the migration and wintering ranges are capable of devastating effects. In Canada, the proposed Fundy Tidal Power scheme would have drastic effects on major migration areas on the east coast. The Grand Canal Scheme (Bourassa 1985), which might involve the transformation of James Bay into a freshwater reservoir, would devastate critically important migration areas used by shorebirds and other groups of birds.

In the United States, industrial development, land reclamation, tanker traffic, pollution, and recreation threaten many important shorebird areas on both east and west coasts and in Alaska. Losses of wetland habitats in the United States over the past century have been substantial, with estimates of 30–40% nationally and even higher losses regionally and locally, e.g., 67% in California and 75% in San Francisco Bay (Senner and Howe 1984).

In South America, internationally important areas for shorebirds are threatened by a variety of factors—agricultural and pesticide pollution in the Guianas, industrial and port developments in north-central Brazil, forestry development and shrimp farming in southern Brazil, developments for tourism in northern Argentina, oil development in Tierra del Fuego in southern Argentina and Chile, wetland developments and drainage in Peru, and shrimp farming in Ecuador, among others (Morrison 1984; Morrison *et al.* 1987; Myers *et al.* 1987*a*, 1987*b*).

Although some of these developments clearly threaten specific areas of major importance, with the potential for direct, catastrophic impact, the effect of "creeping erosion" by smaller-scale, piecemeal developments affecting areas over a larger geographical range must also be considered. Their cumulative effects can lead to the degradation of the entire system beyond the point of no return. Although the details of development proposals may change with time, the fact remains that there are widespread concerns over large geographical areas that are likely not to diminish, but rather to increase in the foreseeable future.

5.4. The Western Hemisphere Shorebird Reserve Network conservation initiative

One of the most important results to have emerged from distributional studies is the demonstration that most of the species using coastal wintering or migration areas are far from evenly distributed, but are concentrated to a remarkable degree in a limited number of sites or in a restricted part of the range (e.g., Morrison and Harrington 1979; Morrison 1983, 1984; Morrison and Myers 1987; Piersma *et al.* 1987).

As information on shorebird distribution over large geographical areas became available, the concept emerged of creating a series of linked reserves to protect the key sites upon which the birds depend throughout their ranges (Morrison 1983, 1984; Myers *et al.* 1987*a*, 1987*b*). The concept has gained widespread acceptance and has been successfully translated from an idea into concrete action through its adoption in North America by the International Association of Fish and Wildlife Agencies and other government agencies and international conservation organizations, including the Canadian Wildlife Service, the US Fish and Wildlife Service, World Wildlife Fund, the National Audubon Society, The (US) Nature Conservancy, the Manomet Bird Observatory, the International Waterfowl and Wetlands Research Bureau, the International Council for Bird Preservation, the International Union for the Conservation of Nature and Natural Resources, and a variety of other bodies, especially through the efforts of Myers and co-workers (Myers *et al.* 1987*a*, 1987*b*). The proposed international network of sites has been named the Western Hemisphere Shorebird Reserve Network (Myers *et al.* 1987*a*, 1987*b*).

The power of this concept lies not only in its philosophical attractiveness and timeliness, in demonstrating that the birds are shared by nations spread from one end of the Western Hemisphere to the other, but in a sound understanding of the biology of the animals. Four fundamental aspects of the natural history of shorebird populations give concern for their conservation, and all are addressed by the Western Hemisphere Shorebird Reserve Network concept. First, as demonstrated by the research described in these volumes and by other studies, shorebirds concentrate in large numbers in a restricted number of sites during different phases of their annual cycles. The significance of this phenomenon is that it breaks the normal link between a species' abundance and its immunity to extinction: even though a species may be numerically abundant, large proportions of the population may be susceptible to environmental threats because they are present at the same place at the same time. Second, the life-history characteristics of shorebirds place them at risk from environmental threats. Shorebirds have low reproductive rates because of small clutch sizes, short breeding seasons, and uncertain breeding success. With low reproductive rates, adult survival is generally high (Boyd 1962; Evans and Pienkowski 1984). Shorebird populations are therefore particularly vulnerable to events affecting adult or subadult survival, especially away from the breeding grounds (Goss-Custard 1979). Third, time constraints imposed by the seasonal availability of habitats and food resources at various phases of the annual cycle mean that shorebirds have little leeway in the timing of their migratory movements. Disruption of the resources available along their migration pathways may thus have drastic effects on their ability to complete migration successfully—and thus to survive from one season to the next. Fourth, shorebirds often find themselves in competition with man—many of the sites used by shorebirds during migration and in winter are also prime targets for development by man. The result is that many of the sites of critical importance to shorebirds may become threatened or lost as a result of human activity.

Concern over loss of shorebird habitats does not relate simply to the threat to a population of wild birds. Shorebirds concentrate in particular places because such areas are especially biologically productive, and it is the biological productivity of these areas upon which many human activities are based. Shorebirds are, in fact, excellent indicators not only of the productivity of a particular area but also of its biological health. The continued biological functioning of ecosystems upon which birds are dependent is thus of vital concern to human populations. As our world becomes more heavily developed and polluted, shorebirds can serve as a valuable indicator of problems that will certainly also affect mankind. With their long migrations spanning the hemisphere, they draw attention to environmental concerns on an international scale. The challenge of maintaining healthy shorebird populations is related directly to our own future survival.

5.4.1. Potential Western Hemisphere Shorebird Reserve Network sites for wintering shorebirds in South America

Two categories of sites are recognized for membership in the Western Hemisphere Shorebird Reserve Network:

(1) "Hemispheric" sites are those that support over 250 000 shorebirds during the course of a year, or 30% of the flyway population of a single species. The term "flyway population" in this case refers to a distinct population of shorebirds using a major definable migration corridor (Morrison and Myers 1987).

(2) "Regional" sites are those that support more than 20 000 shorebirds in a year, or over 5% of a species' flyway population. Criteria for identifying Regional sites are intended to be fairly flexible, and sites may also be nominated for Regional status where they do not meet the above numerical criteria but are recognized as especially important to shorebirds on a national, regional, or local basis, or perhaps because of the significant habitats they contain.

The two-tiered system has been adopted to allow for special recognition of the mega-sites, or superstars of the network, while allowing flexibility in including a wider range of other sites that are locally or regionally important and for which conservational action is desirable.

A preliminary listing of potential Western Hemisphere Shorebird Reserve Network sites in South America, based on the coastal distribution of wintering populations as determined in this Atlas, is given in Table 5.1, with locations illustrated in Fig. 5.1. It must be emphasized that this listing is preliminary and intended to serve as a working document to assist or stimulate future research.

Nine sites in South America have been identified as being of Hemispheric significance for wintering populations of shorebirds (see Table 5.1, Fig. 5.1). All hold extremely large concentrations and/or major proportions of a flyway population of one or several species of shorebirds. In some cases, sites are listed only in very broad geographical terms, e.g., Suriname, Peru/northern beaches, rather than as specific geographical locations: areas within a broadly designated region at which major concentrations of shorebirds occurred may be found by reference to the text of the Atlas. Until more is known of the mobility of shorebirds on the wintering grounds, it is more realistic and effective to base conservational requirements on broad areas involving a complex of sites rather than by nominating only a very circumscribed area for reserve status.

The list of 42 Regional sites in Table 5.1 is very much a preliminary inventory and reflects the application of the flexible criteria mentioned above. Many of the sites listed on the north and Atlantic coasts of South America can be identified on numerical criteria, supporting at least 20 000 shorebirds or over 5% of the flyway population of a species. Many on the Pacific coast, however, have been listed not so much because of the number of shorebirds present (which was often quite low), but because of the isolated or special nature of the habitat (e.g., isolated wetlands at river mouths on the coast of Peru). Other sites will certainly be identified or upgraded because of their importance during migration periods. Examples of such sites include the Mejia Lagoons and the Paracas/Pisco area in Peru, the Gulf of Guayaquil in Ecuador, and possibly the entrance to Lake Maracaibo in Venezuela.

Table 5.1
A preliminary listing of potential Western Hemisphere Shorebird Reserve Network sites for wintering populations of Nearctic shorebirds on the coast of South America[a]

No.[b]	Place	Principal species (no. and/or % South American total, or % regional total as stated, or other justification)
Sites with Hemispheric status		
1	Suriname, various sites	total shorebirds (1.53 million) peeps (1.35 million) medium-sized shorebirds (148 000) yellowlegs (66 400, 73%) dowitchers (21 800, 45%) Willet (15 600, 35%)
2	French Guiana, western coast	total shorebirds (431 000) peeps (394 000) medium-sized shorebirds (32 906)
3	North-central Brazil	total shorebirds (327 000) peeps (192 000) Ruddy Turnstone (17 900, 76%) Black-bellied Plover (14 700, 54%) Willet (21 900, 49%) Whimbrel (10 900, 44%) (also medium-sized shorebirds [21%], dowitchers [17%], Red Knot [11%])
4	Lagoa do Peixe/ S. Brazil	Sanderling (6600, 71% Atlantic Coast total) peeps (17 500, 24% Atlantic Coast total) (also Red Knot, Hudsonian Godwit on migration, wintering Lesser Golden-Plovers)
5	Bahia San Sebastian and Atlantic coast Tierra del Fuego, Argentina	Hudsonian Godwit (19 400, 43%) peeps/White-rumped Sandpipers (23 300, 32% Atlantic Coast total) (also Red Knot [10 500, 14%])
6	Bahia Lomas, Chile	Red Knot (41 700, 55%) Hudsonian Godwit (10 500, 23%) peeps (11 200, 15% Atlantic Coast total)
7	Chiloe area, S. Chile	Hudsonian Godwit (12 600, 28%; 99% Pacific Coast total) Whimbrel (6200, 25%; 66% Pacific Coast total) (also peeps [9000, 15% Pacific Coast total], Sanderling [10 200, 10% Pacific Coast total])
8	Peru, northern beaches/ Chiclayo eco-unit	Sanderling (31 600, 32% Pacific Coast total)
9	Virrila estuary, Peru	peeps (20 000, 43% Pacific Coast total) medium-sized shorebirds (10 300, 30% Pacific Coast total)
Sites with Regional status		
1	Lake Maracaibo entrance, Venezuela	Red Knot (6% North Coast total) (also Red Knot and peeps during migration)
2	North-central coast lagoons, Venezuela	dowitchers (7100, 15% North Coast total) (also peeps during migration)

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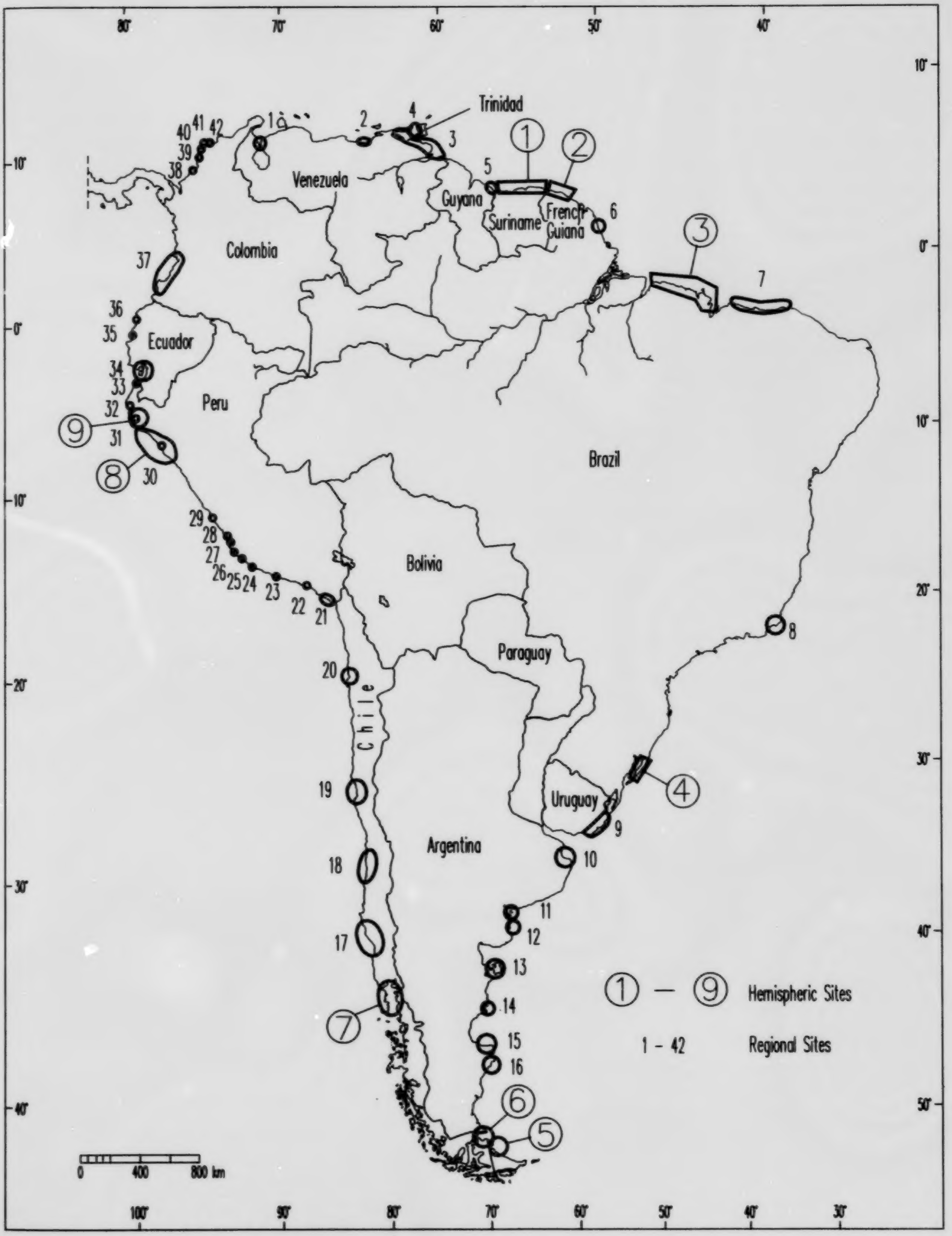
[a] For criteria for inclusion as a "Hemispheric" or "Regional" site, see text.
[b] Numbers refer to site locations illustrated in Fig. 5.1.

(Continued)

Table 5.1 *(Continued)*
A preliminary listing of potential Western Hemisphere Shorebird Reserve Network sites for wintering populations of Nearctic shorebirds on the coast of South America[a]

No.[b]	Place	Principal species (no. and/or % South American total, or % regional total as stated, or other justification)
3	Orinoco delta, Venezuela	small shorebirds (69 000) Sanderling (11% North Coast total) dowitchers (6.5% North Coast total)
4	Trinidad, west coast	significant habitat (peeps [13 600])
5	Guyana, eastern shores	total shorebirds (21 800) yellowlegs (7.5%) dowitchers (5.9%)
6	Brazil, northern coast	peeps (25 600)
7	Brazil, northeastern coast	Sanderling (8.7% North Coast total) Black-bellied Plover (5.4% North Coast total)
8	Brazil, Rio coast (Lagoa Feia area)	yellowlegs (4500, 5.3%)
9	Uruguay, coastal lagoons	total shorebirds (10 500, 5.2% Atlantic Coast total) Lesser Golden-Plover (78% coastal total)
10	Bahia Samborombon, Argentina	significant habitat (Hudsonian Godwit on migration)
11	Bahia Blanca, Argentina	significant habitat
12	Bahia Union/Bahia Anegada, Argentina	peeps (4500, 6.4% Atlantic Coast total) significant habitat
13	Peninsula Valdes, Argentina	Sanderling (14% Atlantic Coast total) Red Knot (5000, 6.5%) (also Red Knot on migration)
14	Bahia Bustamante, Argentina	Red Knot (7400, 11% Atlantic Coast total) (also peeps)
15	Caleta Olivia – Cabo Blanco, Argentina	peeps (7.1% Atlantic Coast total) (also Hudsonian Godwit, Red Knot)
16	Punta Medanosa, Argentina	significant habitat
17	Concepcion eco-unit sites, Chile	Whimbrel (6.6% Pacific Coast total) (also Sanderling)
18	Valparaiso eco-unit sites, Chile	Sanderling (8400, 5.4% Pacific Coast total)
19	La Serena eco-unit sites, Chile	(Sanderling)
20	Mejillones area, Chile	(Sanderling)
21	S. Peru beaches, Tacna area	Sanderling (6200, 5.5%)
22	Rio Locumba/ Punta Coles, Peru	significant habitat
23	Mejia Lagoons/ Rio Tambo, Peru	significant habitat
24	Rio Camana, Peru	yellowlegs (900)
25	Rio Yauca/Rio Acari, Peru	significant habitat (Sanderling)
26	Punta Lomitas, Peru	significant habitat (Sanderling)
27	Paracas Bay/ Rio Pisco, Peru	Sanderling (7700, 8.1%)
28	N. Rio Chincha, Peru	significant habitat (Sanderling)
29	El Paraiso lagoon area, Peru	significant habitat
30	Rio Eten, Peru	significant habitat yellowlegs, Sanderling
31	Rio Piura, Peru	significant habitat Sanderling, Willet, peeps
32	Rio Chira, Peru	significant habitat
33	Tumbes area, Peru	significant habitat
34	Gulf of Guayaquil, Ecuador	significant habitat
35	Bahia de Caraquez, Ecuador	significant habitat
36	Cojimies/Muisne area, Ecuador	significant habitat
37	mangrove coasts, Tumaco–Buenaventura, Colombia	peeps (23 900) medium-sized shorebirds (18% Pacific Coast total) (also dowitchers, Black-bellied Plover, Willet)
38	Rio Sinu/Golfo de Morrosquillo, Colombia	significant habitat
39	S. Cartagena, Colombia	significant habitat
40	Cienaga de Tesca, Colombia	significant habitat
41	Galerazamba area, Colombia	significant habitat (peeps, dowitchers)
42	Rio Magdalena area, Colombia	significant habitat (Black-bellied Plover)

Figure 5.1
Locations of potential Western Hemisphere Shorebird Reserve Network sites for wintering Nearctic shorebirds on the coast of South America, based on surveys in 1982–86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Ecuador
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Uruguay
Argentina
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
① – ⑨ Hemispheric Sites
1 - 42 Regional Sites
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Volume

2

ATLAS of Nearctic shorebirds on the coast of South America

Environment Canada
Canadian Wildlife Service

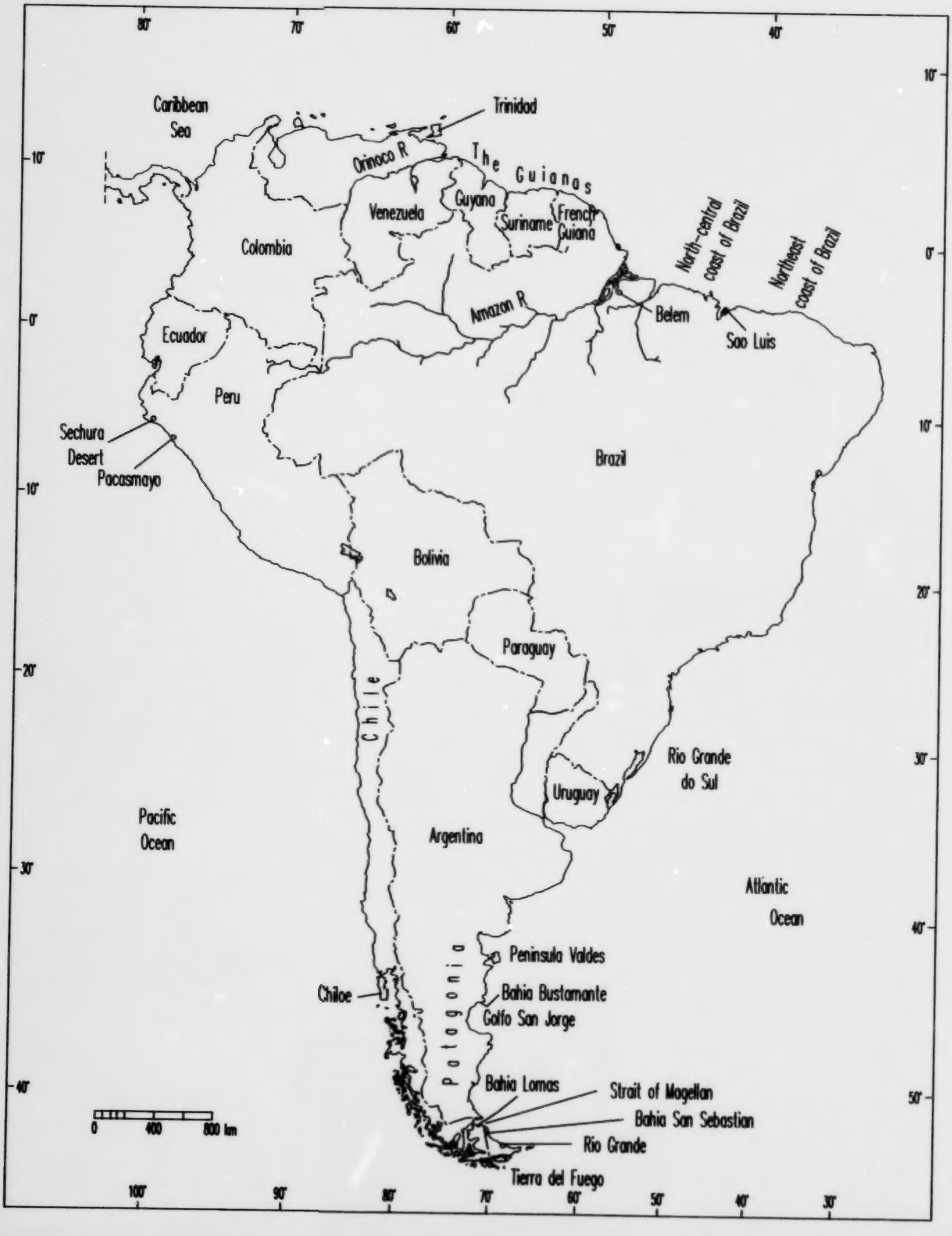
Environnement Canada
Service canadien de la faune

Volume 2

R.I.G. Morrison and
R.K. Ross

Canadian Wildlife Service Special Publication

Locations of major wintering areas of Nearctic shorebirds referred to in the Atlas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Colombia
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Northeast coast of Brazil
Amazon R
Belem
Sao Luis
Ecuador
Peru
Sechura Desert
Pacasmayo
Brazil
Bolivia
Paraguay
Chile
Rio Grande do Sul
Uruguay
Pacific Ocean
Argentina
Atlantic Ocean
Peninsula Valdes
Patagonia
Chiloe
Bahia Bustamante
Golfo San Jorge
Bahia Lomas
Strait of Magellan
Bahia San Sebastian
Rio Grande
Tierra del Fuego
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Atlas of Nearctic shorebirds on the coast of South America

in two volumes

Volume 2

R.I.G. Morrison and
R.K. Ross
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How to use the Atlas

This Atlas consists of two volumes. Volume 1 (Chapter 1-5) contains the Introduction (Chapter 1), Methods (Chapter 2), and Overview (Chapter 3), which summarizes the distribution of shorebirds on the coast of South America on a continental level. The Overview is presented in English, French, Spanish, and Portuguese. Chapter 4 discusses shorebird distribution in relation to geomorphology and environmental conditions, and Chapter 5 reviews the need for international cooperation in the conservation of shorebirds, citing the Western Hemisphere Shorebird Reserve Network as an example of a major conservation initiative that has arisen from internationally coordinated distributional studies.

Volume 2 (Chapters 6-15) gives detailed information on shorebird distribution in South America country by country, proceeding clockwise around the continent. Data for each survey sector are summarized by size category on the maps, to enable ready identification of areas supporting large concentrations of birds. Details of the species observed appear in tables facing the maps.

For distributional analysis on a broad geographical scale, survey sectors are grouped first into eco-units, which are areas of broadly similar habitats, and then into three major regions: North Coast, Atlantic Coast, and Pacific Coast (indicated by capitalization in the text). Each of the chapters devoted to shorebird distribution in a single country is intended to stand as an independent unit, but for ease of reference a brief summary of survey results from the continental perspective is included at the beginning of Volume 2 in English, French, Spanish, and Portuguese.

An index to all maps follows the Table of Contents in both volumes. Shorebird abundance in each survey sector on the maps is shown by circles representing different size categories of shorebirds: small (S), medium-sized (M), and large (L). The circles are always arranged in the order S-M-L, with the S circle closest to the coastline. At least one set of circles on each map is labelled so that this convention is clear.

Organisation de l'Atlas

L'Atlas est formé de deux volumes. Le volume 1 (chapitres 1-5) comprend l'Introduction (Chapitre 1), une section intitulée Methods (Chapitre 2) et une autre intitulée Overview (Chapitre 3), qui fournit un aperçu de la distribution des oiseaux de rivage néarctiques sur les côtes de l'Amérique du Sud. Cette dernière section est présentée en anglais, en français, en espagnol et en portugais. Le chapitre 4 traite de cette question par rapport aux conditions géomorphologiques et environnementales existantes et le chapitre 5 traite de la nécessité d'une collaboration internationale, telle qu'illustrée par la création du Réseau de réserves pour les oiseaux de rivage dans l'hémisphère occidental, une initiative d'envergure qui est le fruit de l'intégration à l'échelle internationale de diverses études de distribution.

Le volume 2 (chapitres 6-15) fournit une description détaillée de la distribution des oiseaux de rivage néarctiques dans chaque pays de l'Amérique du Sud et ce, au moyen d'un survol du continent effectué dans le sens des aiguilles de la montre. Les données pour chaque secteur de dénombrement sont résumées sur des cartes par catégorie de taille, de façon à permettre l'identification rapide des régions qui regroupent les grandes concentrations d'oiseaux. Les précisions sur les groupes d'espèces observés figurent sur des tableaux accompagnant chaque carte. Aux fins d'une analyse de distribution géographique élargie, les secteurs de dénombrement sont groupés en éco-unités, ou régions formées d'habitats généralement identiques, elles-mêmes regroupées en trois régions principales : côte nord, côte Atlantique et côte Pacifique. (Dans le corps du texte anglais, l'emploi de la majuscule initiale permet de distinguer chaque région de la côte elle-même.) Chaque chapitre, conçu de façon à limiter l'analyse de la distribution à un seul pays, peut être consulté séparément. Le lecteur trouvera enfin en introduction au volume 2 un sommaire des résultats de dénombrements, présentés dans la perspective globale du continent et publié en anglais, en français, en espagnol et en portugais.

La liste des cartes suit la Table des matières dans l'un et l'autre volume. L'abondance des oiseaux de rivage dans chaque secteur de dénombrement est indiquée au moyen de cercles de grandeur diverse représentant chacune des trois catégories de taille d'oiseau : petite (S), moyenne (M), et grande (L). Ces cercles figurent toujours dans l'ordre susmentionné, le cercle (S) étant immédiatement adjacent au tracé des côtes. Sur chaque carte, au moins un jeu de cercles est toujours codé de façon à éviter toute confusion.

Organización del Atlas

Este Atlas se compone de dos volúmenes. El Volumen 1 (Capítulos 1-5) contiene la Introducción (Capítulo 1), Métodos (Capítulo 2), e Sobrevuelo (Capítulo 3), en que se resume la distribución de las aves de orilla marina en América del Sur, a nivel continental. El sobrevuelo de la distribución continental se presenta en inglés, francés, español y portugués. El Capítulo 4 se analiza la distribución de las aves de orilla marina en relación con la geomorfología y las condiciones ambientales, y el Capítulo 5 se estudia la necesidad de cooperación internacional para la conservación de las aves de orilla marina, poniendo a la Red Hemisférica de Reservas de Aves Playeras como ejemplo de importante iniciativa de conservación, surgida de estudios internacionalmente coordinados de distribución.

El Volumen 2 (Capítulos 6-15) proporciona información detallada sobre la distribución de las aves de orilla marina en América del Sur, país por país, analizándose los diferentes países de ese sub-continente siguiendo la dirección de las manecillas del reloj. En los mapas se resumen los datos correspondientes a cada sector del estudio por categoría de tamaño, lo que permite la fácil identificación de las áreas donde hay grandes concentraciones de aves. En las tablas que aparecen enfrente de los mapas se dan detalles de las especies observadas.

Para el análisis de distribución en una escala geográfica amplia, los sectores estudiados se agrupan primero en eco-unidades, que son aquellas áreas que tienen habitats similares, en términos generales, y posteriormente en tres regiones principales: costa norte, costa del Atlántico y costa del Pacífico (lo que se indica en el texto inglés empleando mayúsculas). Cada uno de los capítulos dedicados a la distribución de aves de orilla marina en un solo país constituye una unidad independiente, pero para facilitar el trabajo de referencia, a comienzos del Volumen 2 se incluye en inglés, francés, español y portugués un breve sumario de los resultados del estudio desde una perspectiva continental.

El índice de mapas sigue al Indice de cada volumen. La abundancia de aves de orilla marina en cada sector estudiado se indica en los mapas mediante círculos cuyo diámetro refleja la concentración de aves de orilla marina: pequeño (S), mediano (M) y grande (L). Los círculos aparecen siempre en el orden S-M-L, siendo siempre el círculo S mayúscula el más cercano a la costa. En cada mapa se rotula, por lo menos, un juego de círculos para evitar la confusion.

Composição do Atlas

O presente Atlas compõe-se de dois volumes. O volume 1, que contém os capítulos 1 a 5: Introdução (Capítulo 1), Métodos (Capítulo 2) e Apanhado geral (Capítulo 3). O capítulo 3 sumariza a distribuição das aves litorâneas no litoral da América do Sul à escala continental. O apanhado aparece redigido em inglês, francês, espanhol e português. O capítulo 4 analisa a distribuição das aves litorâneas, em função da geomorfologia e das condições ambientais. O capítulo 5 examina a necessidade de cooperação internacional no tocante à conservação das aves litorâneas, citando o "Western Hemisphere Shorebird Reserve Network" como um exemplo de initiativa de conservação, surgida de estudos de distribuição internacionalmente coordenados.

O volume 2, que contém os capítulos 6 a 15, fornece pormenorizadas informações sobre a distribuição das aves litorâneas na América do Sul, ordenadas seqüencialmente por país, em sentido circular da direita para a esquerda em torno do continente. Os dados referentes a cada setor sondado são resumidos em mapas, por categorias de tamanho, a fim de permitir a rápida identificação das áreas que sustentam grandes concentrações de aves. Os quadros contrapostos aos mapas fornecem detalhes sobre as espécies observadas.

Para permitir uma análise em grande escala da distribuição geográfica, os setores de sondagem são, primeiramente, agrupados em eco-unidades, que são áreas de *habitats* geralmente similares, e, seguidamente, consolidados em três regiões principais, a saber: costa do Norte, costa do Atlântico e costa do Pacífico (indicadas a letra maiúscula no texto inglês). Cada um dos capítulos dedicados à distribuição das aves litorâneas em determinado país é válido como unidade independente; contudo, para facilidade de consulta, fornece-se no começo do volume 2 um breve sumário dos resultados das sondagens, em inglês, francês, espanhol e português, sob um prisma continental.

Um índice de todos os mapas segue o índice geral de cada volume. A abundância das aves litorâneas em cada setor de sondagem focado nos mapas está indicado por círculos representativos das aves litorâneas de diferentes categorias de tamanho: pequeno (S), médio (M) e grande (L). Os círculos estão dispostos sempre na ordem "S-M-L," com o círculo "S" mais próximo ao litoral. Cada mapa contém pelo menos um jogo de círculos rotulado para evitar a confusão.

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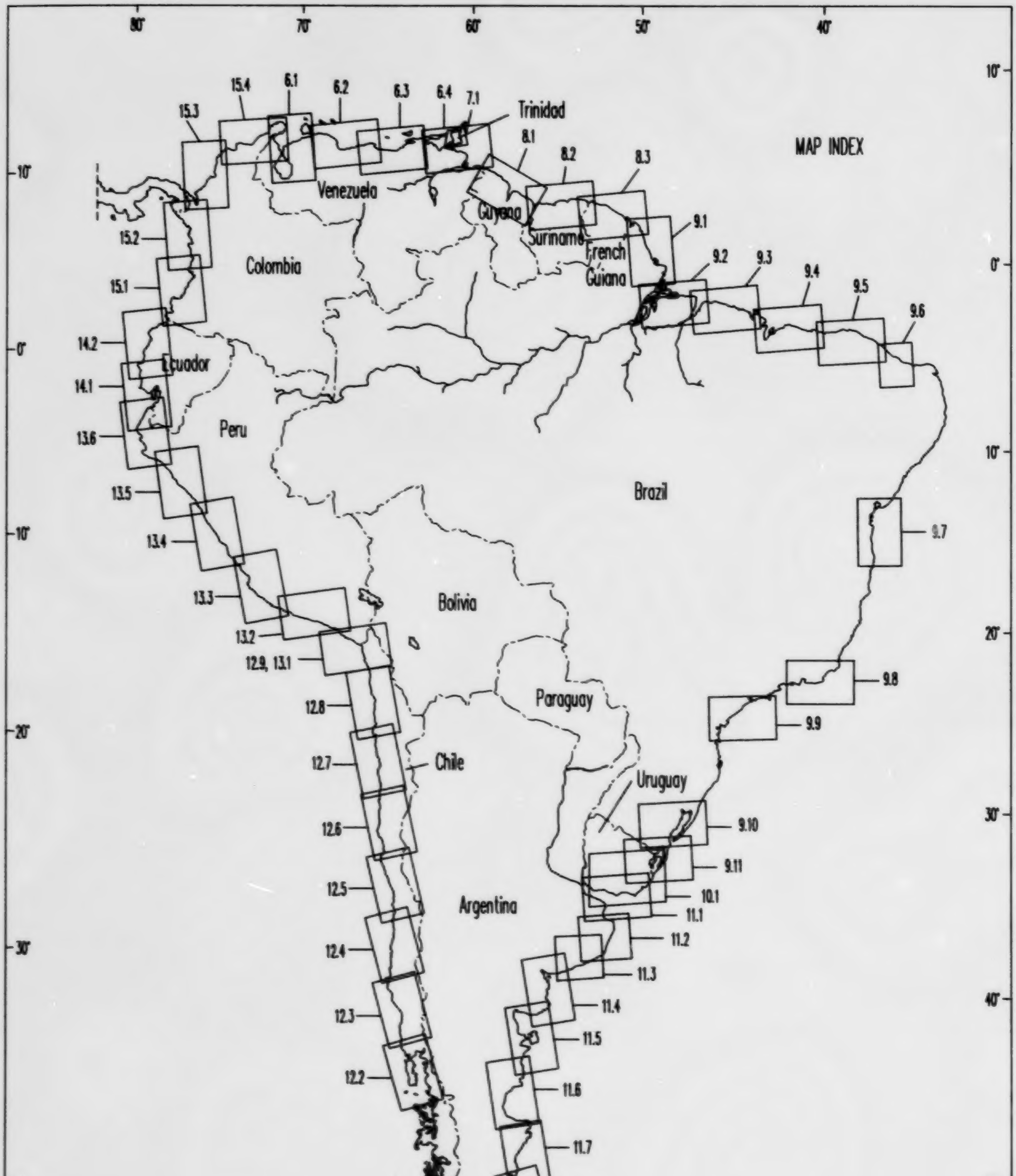
Map index

Map coverage of the coastline of South America for the main series of survey maps, showing distribution of Nearctic shorebirds summarized by size category, is illustrated in the Map index. Locations of maps in the Atlas are indicated in the List of maps.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Summary

This Atlas presents the results of aerial surveys undertaken to determine the principal wintering areas used by Nearctic shorebirds on the coast of South America. The surveys, carried out in January/February from 1982 to 1986, covered some 28 000 km of the South American coastline and included all parts of the coast thought to contain significant habitat for shorebirds.

More than 2.9 million Nearctic shorebirds were counted during the surveys, with small, medium-sized, and large species making up 80, 16, and 4% of the total, respectively.

The surveys clearly identified the most important coastal wintering areas used by various categories and species of shorebirds (see inside front cover for locations of sites mentioned in the Atlas). Some 2.1 million small sandpipers were counted on the north coast of South America, the majority of which were considered to be Semipalmated Sandpipers *Calidris pusilla*. The most important wintering areas occurred in Suriname and French Guiana, with 64 and 19%, respectively, of the total. Other major areas included the north-central coast of Brazil between Belem and Sao Luis, with 9% of the total, and the Orinoco delta, with 3%. Small sandpipers occurring along the southern parts of the Atlantic coast consisted principally of White-rumped Sandpipers *Calidris fuscicollis*. Particularly important wintering areas included the Argentinian and Chilean sectors of Tierra del Fuego, with 32 and 15%, respectively, of the regional total of 73 000; other important areas included coastal lagoons in southern Brazil and in Uruguay, with a further 21 and 4%, respectively, of the total.

Nearly 112 000 Sanderlings *Calidris alba* were counted. The most important wintering areas were the ocean beaches of the Pacific coast: the Pacific, Atlantic, and north coasts held 88, 8, and 4%, respectively, of the total. Most of the Sanderlings on the Pacific coast occurred in Peru and Chile, which held 68 and 31%, respectively, of the regional total. Areas of major concentration in Peru included the ocean beaches fronting the Sechura Desert (32%) and the coast near Pacasmayo (10%), with areas of central and southern Peru also holding substantial numbers (19 and 15%, respectively). Moderate to large numbers occurred in central and southern Chile, with some 10% of the west coast total in Chiloe. On the Atlantic coast, the most important area for Sanderlings was the coastline of Rio Grande do Sul in southern Brazil, with 71% of the Atlantic coast total.

Important areas for medium-sized species were found along the north coast and in the far south of the continent. Most Black-bellied Plovers *Pluvialis squatarola* (total 27 300) occurred in the northern part of the continent, with major wintering areas being found on the north-central coast of Brazil (54%) and in Suriname (15%), with smaller, more localized concentrations on the Caribbean coast of Colombia (5%), northeastern Brazil (5%), and Peru (5%). Ruddy Turnstones *Arenaria interpres* were most numerous on the north coast of the continent and fairly common on the Pacific coast, these areas holding 86 and 10%, respectively, of the continental total of 23 500. The north-central coast of Brazil was the most important wintering area, holding 76% of the South American total. Most (91%) of the 91 000 yellowlegs (Lesser Yellowlegs *Tringa flavipes* and Greater Yellowlegs *T. melanoleuca*) were found on the north coast of the continent, with the majority occurring in the Guianas (Suriname 73%, Guyana 8%, French Guiana 6%).

The most important wintering grounds for the Red Knot *Calidris canutus* were in Tierra del Fuego and along the Patagonian coastline of Argentina. Of the total of 76 400 counted, 55% occurred at one site, Bahia Lomas near the eastern entrance to the Strait of Magellan in Chilean Tierra del Fuego. Other important concentrations in Tierra del Fuego were found near Rio Grande and in Bahia San Sebastian in Argentina. On the Patagonian coast of Argentina, important areas were found around the Golfo San Jorge, near Bahia Bustamente, and around the Peninsula Valdes.

Short-billed Dowitchers *Limnodromus griseus* were restricted to the northern part of the continent, which held 97% of the total of 48 900. Particularly important areas included the mangroves and coastal lagoons of Suriname (45%), north-central Brazil (17%), and central Venezuela (15%); smaller numbers occurred in the Orinoco delta (6%), Guyana (6%), and French Guiana (5%).

Willets *Catoptrophorus semipalmatus* (total 44 400) were found mostly (89%) on the north coast of the continent. The two major wintering areas were in north-central Brazil (49%) and in Suriname (35%).

Coastal wintering areas for Hudsonian Godwits *Limosa haemastica* were in the far south of the continent, with 72 and 28% of the total of 45 500 birds occurring on the Atlantic and Pacific coasts, respectively. The most important sites were in Tierra del Fuego, with Bahia San Sebastian, Argentina, and Bahia Lomas, Chile, supporting 43 and 23%, respectively, of the South American total. A further 28% of the total was found in the Chiloe area of southern Chile.

Whimbrels *Numenius phaeopus* were widely distributed, occurring principally on the north and Pacific coasts of South America. Three main wintering areas were evident, with north-central Brazil and Suriname on the north coast and the Chiloe area on the Pacific coast supporting 44, 13, and 25%, respectively, of the total of 25 000 counted on the surveys.

Major wintering sites are located in areas where geomorphological and environmental (e.g., climatic, oceanographic) conditions combine to produce habitats that are particularly productive. The surveys have demonstrated that coastal wintering populations of shorebirds in South America are concentrated into a restricted part of the range, with substantial percentages often occurring at a limited number of sites. This phenomenon is of considerable conservational significance, since it implies that environmental problems in a key area may be capable of causing major damage to a population. The present research, in conjunction with studies in other parts of the birds' migration ranges, has led directly to the concept of setting up a series of linked reserves that would protect the key sites used by the birds throughout their ranges. Such an international approach, involving the creation of a Western Hemisphere Shorebird Reserve Network, will be essential if the future conservation of shorebirds is to be effective.

Sommaire

Le présent atlas illustre les résultats de relevés aériens menés afin de nous permettre de déterminer les principales «aires d'hivernage» sur les côtes de l'Amérique du Sud des oiseaux de rivage de la région néarctique. Les relevés, qui ont été effectués durant les mois de janvier et février entre 1982 et 1986, ont permis de couvrir environ 28 000 km de rivage en Amérique du Sud, notamment toutes les parties de la côte dont on estimait qu'elles constituaient un habitat important pour les oiseaux de rivage.

Plus de 2,9 millions d'oiseaux de rivage de la région néarctique ont été dénombrés au cours de ces relevés; les petites, moyennes et grosses espèces constituaient 80 %, 16 % et 4 % du total, respectivement.

Les relevés ont nettement permis d'établir quelles sont les principales aires d'hivernage côtières occupées par les différentes catégories et espèces d'oiseaux de rivage. (Voir le plat recto inférieur pour l'emplacement des sites mentionnés dans le présent Atlas.) On a dénombré environ 2,1 millions de petits bécasseaux sur la côte nord de l'Amérique du Sud, la majorité étant, estime-t-on, des Bécasseaux semipalmés *Calidris pusilla*. Les plus importantes aires d'hivernage ont été trouvées au Surinam et en Guyane française, avec 64 % et 19 % du total, respectivement. On a trouvé d'autres aires importantes dans le secteur centre-nord de la côte du Brésil, entre Belém et São Luis, où 9 % du total des oiseaux a été observé, ainsi que dans le delta de l'Orénoque, avec 3 % du total. Parmi les petits bécasseaux trouvés le long des secteurs sud de la côte atlantique, on comptait principalement le Bécasseau à croupion blanc *Calidris fuscicollis*. Des aires d'hivernage particulièrement importantes se trouvent dans les secteurs de la Terre de Feu du côté de l'Argentine comme du côté du Chili, où sont regroupés 32 % et 15 % du total régional, soit 73 000 sujets; les lagunes côtières du sud du Brésil et de l'Uruguay constituent également des aires importantes et regroupent 21 % et 4 % du total, respectivement.

Près de 112 000 Bécasseaux sanderlings *Calidris alba* ont été dénombrés; les plages du Pacifique constituent les principales aires pour cette espèce : on a observé que les côtes du Pacifique, celles de l'Atlantique et la côte nord regroupaient 88 %, 8 % et 4 % du total, respectivement. La plupart des Bécasseaux sanderlings retrouvés sur la côte du Pacifique l'ont été au niveau du Pérou et du Chili, qui regroupaient chacun 68 % et 31 % du total régional. Les régions de concentration majeure au Pérou étaient notamment les plages littorales à hauteur du désert de Sechura (32 %) et la côte près de Pacasmayo (10 %); certains secteurs des parties centrales et du sud du Pérou réunissaient également une proportion importante des sujets (19 % et 15 %, respectivement). Un nombre modéré à élevé d'oiseaux a été trouvé vers le centre et vers le sud du Chili, notamment avec 10 % du total de la côte ouest à Chiloé. Sur la côte atlantique, la principale aire de regroupement du Bécasseau sanderling est constituée par le rivage du Rio Grande do Sul dans la partie sud du Brésil, qui regroupe 71 % du total de ce bécasseau sur la côte atlantique.

Les aires importantes pour les espèces de taille moyenne ont été observées le long de la côte nord et loin au sud. La plupart des sujets du Pluvier argenté *Pluvialis squatarola* (total de 27 300) a été trouvée dans la partie nord du continent, les principales aires étant situées dans la partie centre-nord de la côte du Brésil (54 %) et au Surinam (15 %); il existe de plus petites concentrations, plus localisées, sur la côte de la Colombie devant la mer des Caraïbes (5 %), dans la partie nord-est du Brésil (5 %) et au Pérou (5 %). Le Tournepierre à collier *Arenaria interpres* se trouve en plus grande abondance sur la côte nord du continent et il est assez commun sur la côte du Pacifique (86 % et 10 %, respectivement, du total de 23 500 observé sur le continent). La côte centre-nord du Brésil constitue la plus importante aire d'hivernage, avec 76 % du total pour l'Amérique du Sud. La majorité (91 %) des 91 000 Grands Chevaliers et Petits Chevaliers *Tringa flavipes* et *T. melanoleuca* a été observée sur la côte nord du continent, la majorité dans les Guyanes (Surinam 73 %, Guyana 8 %, Guyane française 6 %).

La Terre de Feu constitue la principale aire d'hivernage du Bécasseau maubèche *Calidris canutus* avec le rivage de la Patagonie argentine. Des 76 400 sujets dénombrés, 55 % a été trouvé dans une aire, Bahia Lomas, à proximité de l'embouchure est du détroit de Magellan, en Terre de Feu (Chili). D'autres concentrations importantes ont été observées dans la Terre de Feu près de Rio Grande et à Bahia San Sebastian, en Argentine. Sur la côte de la Patagonie argentine, d'importantes aires ont été observées dans la région du golfe de San Jorge, près de Bahia Bustamante et autour de la presqu'île de Valdés.

Le Bécasseau roux *Limnodromus griseus* est restreint à la partie nord du continent, qui regroupe 97 % des 48 900 sujets. Les mangroves et les lagunes côtières du Surinam (45 %), de la partie centre-nord du Brésil (17 %) et de la partie centrale du Venezuela (15 %) constituent des aires particulièrement importantes; d'autres Bécasseaux roux se trouvent en moindre abondance dans le delta de l'Orénoque (6 %) en Guyana (6 %) et en Guyane française (5 %).

Le Chevalier semipalmé *Catoptrophorus semipalmatus* (total de 44 400) se trouve principalement (89 %) sur la côte nord du continent. Les deux aires importantes sont situées dans la partie centre-nord du Brésil (49 %) et au Surinam (35 %).

Les aires côtières d'hivernage de la Barge hudsonienne *Limosa haemastica* sont situées très au sud sur ce continent; 72 % et 28 % des 45 500 sujets se trouvent sur les côtes de l'Atlantique et du Pacifique, respectivement. Les principales aires sont situées dans la Terre de Feu, où Bahia San Sebastian (Argentine) et Bahia Lomas (Chili) regroupent 43 % et 23 % du total trouvé en Amérique du Sud, respectivement. Un autre 28 % de cette espèce a été trouvé dans la région de Chiloé, partie sud du Chili.

Le Courlis corlieu *Numenius phaeopus* a une assez vaste distribution; il est trouvé principalement sur la côte nord et la côte du Pacifique du continent sud-américain. Trois grandes aires d'hivernage sont apparentes, soit la partie centre-nord du Brésil et le Surinam sur la rive nord et le secteur de Chiloé sur la côte du Pacifique, qui réunissent 44 %, 13 % et 25 %, respectivement, des 25 000 sujets dénombrés lors des relevés.

Les principales aires d'hivernage sont situées dans des régions où les conditions géomorphologiques et les conditions écologiques (p. ex., le climat et les conditions océanographiques) se combinent pour créer des habitats particulièrement productifs.

Les dénombrements ont permis d'établir que les populations d'oiseaux de rivage qui hivernent dans les secteurs côtiers de l'Amérique du Sud sont concentrées dans des secteurs restreints de l'aire de distribution, souvent avec des regroupements importants dans un nombre limité d'endroits. Ce phénomène a une importance considérable sur le plan de la conservation puisque cela signifie que des

problèmes écologiques dans un secteur pivot sont susceptibles de nuire considérablement à une population donnée. Les présents travaux ainsi que la recherche effectuée ailleurs dans les aires de distribution de ces populations ont directement conduit à l'idée de créer une série de réserves jumelées afin de permettre de protéger les endroits d'importance stratégique pour ces migrateurs.

Il est essentiel d'adopter une telle approche internationale, qui inclut la création du Réseau de réserves pour les oiseaux de rivage dans l'hémisphère occidental afin d'assurer une protection efficace de ces oiseaux.

Sumario

Este atlas presenta los resultados de la evaluación aérea realizada para determinar las principales "áreas de invernada" usadas por las aves de orilla marina del Neártico, en las costas de América del Sur. La evaluación se realizó en los meses de enero y febrero, entre 1982 y 1986, cubriendo alrededor de 28 000 km de líneas costeras de América del Sur, incluyendo hábitats de importante significado para aves de orilla marina.

Durante la evaluación, fueron contados mas de 2.9 millones de aves de orilla marina, de especies de tamaño pequeño, medio y grande, con 80%, 16% y 4% del total, respectivamente.

La evaluación identificó claramente las áreas de invernada más importantes de la costa usadas por varias categorías y especies de aves de orilla marina (véa en el interior de la tapa delantera los lugares mencionados en el Atlas). Alrededor de 2.1 millones de pequeños chorlos, fueron contados en la costa norte de América del Sur, la mayoría de las cuales fueron del playero semipalmado *Calidris pusilla*. Las más importantes áreas de invernada ocurren en Surinam y Guyana Francesa, con 64% y 19% del total, respectivamente. Otras áreas mayores incluyeron la costa norte central del Brasil, entre Belém y São Luís, con 9% del total, y el delta del Orinoco con 3%. Pequeños chorlos, fueron registrados a lo largo de la parte sur de la costa atlántica, principalmente, el playero de lomo blanco *Calidris fuscicollis*. Particularmente importantes áreas de invernada, incluyeron sectores argentino y chileno, de Tierra del Fuego, con 32% y 15% del total regional de 73 000; otras áreas importantes incluyeron lagunas costeras al sur de Brasil y en Uruguay, con más de 21% y 4% del total, respectivamente.

Cerca a 112 000 playeros blanco *Calidris alba*, fueron censados en las áreas más importantes de invernada en las playas de la costa pacífica: el Pacífico, Atlántico y la costa norte contienen el 88%, 8% y 4% del total respectivamente. La mayor parte de los playeros blanco de la costa pacífica, ocurrieron en Perú y Chile, los cuales contienen el 68% y 31% del total regional. Las áreas de mayor concentración en el Perú incluyen las playas del oceano frente al desierto de Sechura (32%) y la costa cerca a Pacasmayo (10%), con áreas al centro y sur del Perú, conteniendo también cantidades substanciales (19% y 15%, respectivamente). Cantidades de moderadas a grandes ocurrieron en la parte central y sur de Chile, con aproximadamente 10% del total en la costa oeste de Chiloé. Sobre la costa atlántica el área más importante para playeros blanco, fue la línea costera de Rio Grande do Sul, al sur de Brasil, con 71% del total de la costa atlántica.

Áreas importantes para especies de tamaño medio, fueron encontradas a lo largo de la costa norte y en el extremo sur del continente. La mayoría de los chorlos ártico *Pluvialis squatarola* (total 27 300), ocurrieron en la parte norte del continente, siendo las mayores áreas de invernada la costa nor-central de Brasil (54%) y Surinam (15%); pequeñas y más localizadas concentraciones fueron registradas sobre la costa caribeña de Colombia (5%), noreste de Brasil (5%) y Perú (5%). El vuelvepiedras *Arenaria interpres* fue más numeroso sobre la costa norte del continente y poco común en la costa pacífica; éstas áreas contienen 86% y 10%, respectivamente, del total continental de 23 500. La costa nor-central de Brasil fue el área más importante de invernada, conteniendo 76% del total de América del Sur. Los más de 91 000 (91%) de los patas amarilla (*Tringa flavipes* y *T. melanoleuca*) fueron encontrados en la costa norte del continente, con una mayor ocurrencia en las Guyanas (Surinam 73%, Guyana 8% y Guyana Francesa 6%).

Las más importantes tierras de invernada para el playero de pecho rojo *Calidris canutus*, fueron Tierra del Fuego y a lo largo de la línea costera de la Patagonia argentina. Del total de 76 400 censados, el 55% ocurrió en Bahía Lomas, cerca a la entrada este del estrecho de Magallanes en Tierra del Fuego, en Chile. Otras importantes concentraciones en Tierra del Fuego fueron encontradas cerca a Río Grande y en Bahía San Sebastián en Argentina. Sobre la costa de la Patagonia en Argentina fueron encontradas importantes áreas alrededor del Golfo San Jorge, cerca a la Bahía Bustamante y alrededor de la Península Valdés.

La Becasina migratoria *Limnodromus griseus* estuvo restringida a la parte norte del continente con un 97% del total de 48 900. Se incluyeron áreas particularmente importantes como los manglares y lagunas costeras de Surinam (45%), nor-central de Brasil (17%) y central de Venezuela (15%): pequeños números ocurrieron en el delta del Orinoco (6%), Guyana (6%) y Guyana Francesa (5%).

El playero de ala blanca *Catoptrophorus semipalmatus* (44 000 total), fue hallado mayormente (89%) en la costa norte del continente. Las dos mayores áreas de invernada estuvieron en la parte nor-central de Brasil (49%) y en Surinam (35%).

Las áreas costeras de invernada para *Limosa haemastica*, estuvieron en el extremo sur del continente, con 72% y 28% del total de 45,500 aves registradas en las costas del Pacífico y del Atlántico, respectivamente. Los sitios más importantes fueron Tierra del Fuego, con Bahía San Sebastián en Argentina y Bahía Lomas en Chile, soportando 43% y 23% del total de América del Sur. De más el 28% del total fue hallado en el área de Chiloé al sur de Chile.

El zarapito trinador *Numenius phaeopus*, estuvo extensamente distribuido, ocurriendo principalmente en el norte y en la costa pacífica de América del Sur. Tres significativas áreas de invernada fueron evidentes, la parte nor-central de Brasil y Surinam en la costa norte y el área de Chiloé sobre la costa pacífica, conteniendo 44%, 13% y 25% del total de 25 000 contados en la evaluación.

Los mejores lugares de invernada están localizados en áreas donde la combinación de condiciones geomorfológicas y ambientales (por ejemplo climáticas, oceanográficas), posee hábitats, los cuales son particularmente productivos.

La evaluación ha demostrado que las poblaciones de aves de orilla, que invernan en las costas de América del Sur, están concentradas y restringidas aparte de este rango, con porcentajes substanciales que ocurren frecuentemente en un limitado número de sitios. Este fenómeno es de considerable significado para la conservación debido a que esto implica que los problemas ambientales en un área clave serían los causantes de un mayor daño a la población. La presente investigación, conjuntamente con estudios realizados en otras partes sobre las rutas de migración de las aves, implica directamente el concepto de una serie de reservas ligadas, la cual protegería los sitios claves usados por las aves, a través de sus rutas. Tal aprovechamiento internacional, envolviendo la creación de la "Red Hemisférica de Reservas de Aves Playeras" es esencial para la conservación de aves de orilla marina.

Sumário

O Atlas apresenta os resultados obtidos durante sobrevôos da costa da América do Sul, em busca das principais áreas de invernada de Charadriidae e Scolopacidae neárticos no litoral do continente. Realizados em janeiro e fevereiro de 1982 e 1986, os sobrevôos cobriram cerca de 28.000 km da costa sulamericana e incluiram áreas conhecidas do litoral com habitat para essas aves migratórias.

Mais de 2,9 milhões de maçaricos e batuíras das duas famílias foram contados durante os censos, subdivididos pelo porte em espécies grandes (4% do total), médias (16%) e pequenas (80%).

Os censos identificaram claramente as principais áreas de invernada costeiras usadas pelas várias espécies e/ou categorias de tamanho de maçaricos (ver no interior da capa frontal os lugares citados no Atlas). Em torno de 2,1 milhões de maçaricos de pequeno porte foram contados na costa setentrional da América do Sul, a maioria dos quais considerados como *Calidris pusilla*. As áreas mais importantes localizadas no Suriname e Guiana Francesa, com 64% e 19% do total, respectivamente. Outra área fundamental foi a costa brasileira, entre Belém e São Luis, com 9% do total, e o delta do rio Orinoco, com 3%. Maçaricos de pequeno porte ocorrendo na meridional da costa atlântica eram, em sua maioria, *Calidris fuscicollis*. Nesta região, as áreas principais estavam na Terra do Fogo, tanto na parte argentina quanto na chilena, representando pela ordem 32% e 15% do total regional de 73.000 aves. Outros pontos destacados foram as lagunas costeiras do sul do Brasil e Uruguai, com 21% e 4% desse mesmo total.

Em torno de 112.000 *Calidris alba* foram contados, localizados principalmente nas praias oceânicas da costa pacífica. Esta porção do continente abrigou 88% do total da costa atlântica e 4% da costa norte do continente. A maioria dos *C. alba* da costa pacífica foram localizados no Peru (68% do total regional) e Chile (31%). Os pontos principais no Peru incluiram as praias oceânicas em frente ao deserto de Sechura (32%) e a costa próxima a Pacasmayo (10%) além de áreas do Peru central e meridional abrigando 19% e 15%, respectivamente. No Chile, grandes e médias concentrações ocorreram na porção central e meridional, sendo que 10% do total da costa ocidental do continente estavam na área da Ilha Chiloé. Já para a costa atlântica, a região mais importante para *C. alba* foi o Rio Grande do Sul, abrigando 71% do total dessa área.

Para as espécies de médio porte os locais mais importantes foram a costa setentrional e o extremo sul do continente. Para *Pluvialis squatarola* (27.300 no total) a maioria das aves estava na parte norte do continente, com as áreas de invernada principais na costa do Brasil (Pará e Maranhão, 54%) e Suriname (15%). Concentrações menores foram anotadas para a costa caribenha da Colômbia (5%), nordeste brasileiro (5%) e Peru (5%). Já *Arenaria interpres* estava presente na costa norte em grandes números e razoavelmente comum na costa pacífica. Essas áreas abrigavam 86% e 10%, pela ordem, do total de 23.500 aves para o continente. O litoral entre Belém e São Luís foi o local mais importante, com 76% do total para a América do Sul. Das 91.000 *Tringa flavipes* e *T. melanoleuca* encontradas, 91% estava na costa setentrional, com a maioria ocorrendo no Suriname (73%), Guiana (18%) e Guiana Francesa (6%).

Já para *Calidris canutus* as principais áreas de invernada foram a Terra do Fogo e ao longo da costa patagônica da Argentina. Do total de 76.400 contados nos censos, 55% ocorreram em um único ponto, Bahia Lomas (situada próxima a boca do Estreito de Magalhães, na Terra do Fogo). Nessa mesma área, outras importantes concentrações estavam próximas a Rio Grande e Bahia San Sebastian na Argentina. Subindo a costa patagônica, outros locais destacados foram o Golfo San Jorge, próximo a Bahia Bustamante e ao longo da Península Valdes.

Quanto a *Limnodromus griseus*, a costa setentrional abrigou 97% de 48.900. Áreas especialmente importantes foram os manguezais e lagoas costeiras do Suriname (45%), costa do Brasil entre Belém e São Luís (17%) e centro da Venezuela (15%); números menores ocorreram no delta do rio Orinoco (6%), Guiana (6%) e Guiana Francesa (5%).

Catoptrophorus semipalmatus (44.400 contados no continente) estava principalmente (89%) na costa norte da América do Sul. Os dois pontos principais estavam na costa entre Belém e São Luís (49%) e no Suriname (35%).

Áreas de invernada costeira para *Limosa haemastica* localizavam-se no extremo sul do continente, com 72% e 28% do total de 45.500 aves ocorrendo na costa atlântica e pacífica, respectivamente. Pontos mais importantes ficaram na Terra do Fogo, com a Bahia San Sebastian (Argentina) e Bahia Lomas (Chile) abrigando 43% e 23% do total da América do Sul. Outros 28% estavam na região da Ilha Chiloé, no Chile meridional.

Numenius phaeopus foi anotado em uma distribuição menos concentrada, ocorrendo principalmente nas costas norte e pacífica do continente. Três áreas de invernada, entretanto, sobressairam-se. A costa entre Belém e São Luís (44%), Suriname (13%) e Ilha Chiloé (25%), dentre do total de 25.000 aves contadas nos sobrevôos.

Essas áreas principais de invernada para as diversas espécies estão localizadas nas seções com condições geomorfológicas e ambientais (por exemplo, climáticas, oceanográficas) combinando-se para produzir habitats particularmente produtivos do ponto de vista biológico.

Os sobrevôos demonstraram que as populações de Scolopacidae e Charadriidae neárticos usando a costa sulamericana durante o inverno boreal estão concentradas em porções do continente, com altas porcentagens em um pequeno número de locais. Esse fenômeno é de alta relevância para a conservação, por significar que problemas ambientais em um desses pontos chave pode ocasionar drásticos efeitos nas populações das espécies ali presentes. A presente pesquisa, em conjunto com estudos realizados em outros pontos ao longo das rotas migratórias dessas aves, levaram ao conceito da necessidade de unidades de conservação interligadas as quais protegeriam os locais primordiais usados pelas aves através da área de ocorrência das espécies. Essa ótica obriga a uma ação conservacionista sobre fronteiras, envolvendo a criação de um sistema de Reservas para Maçaricos no Hemisfério Ocidental, essencial para o futuro desse grupo na face do planeta.

Chapter 6

Venezuela

R.I.G. Morrison, R.K. Ross, F. Espinosa, and D. Figueroa

6.1. General geography

Venezuela lies on the north coast of South America, approximately between the equator and 10°N, and between 60 and 70°W. It is bounded to the west by Colombia, to the north by the Caribbean Sea, to the east by Guyana and the Atlantic Ocean, and to the south by Brazil. It is about 912 050 km^2 in area and has approximately 2800 km of coastline. Some of the main geographical features of Venezuela are illustrated in Fig. 6.1. The country can be divided into a number of major physiographic provinces, which determine the distribution of landforms and habitats along the coast. In the west, Lake Maracaibo occupies about one-quarter of the large, low-lying Maracaibo Basin, a wet and humid area lying between the encircling arms of two major branches of the Andes. These branches are the Sierra de Perija to the west, running along the Venezuela/Colombia border towards the Guajira Peninsula, and the Cordillera de Merida to the southeast, which forms the main branch of the Venezuelan Andes, with elevations of 4000–5000 m. The highest average annual temperatures in Latin America occur in the Maracaibo Basin.

To the north of the Cordillera de Merida, the Segovia Highlands lead to the Coro Lowlands and a dry belt of country surrounding the Gulf of Venezuela; this area contains extensive sand dunes and occasional salinas. The north-central coast of Venezuela is formed by the mountains of the Cordillera de la Costa Central, or Central Coast Range, of the Andes, which rise to 2600–2800 m between Puerto Cabello and Higuerote and contain the capital, Caracas. The east-central coastal plains extend eastwards from Higuerote to Barcelona and consist of a narrow strip of flat terrain containing long beaches and a series of nearshore lagoons, which become extensively inundated during the rainy season. The mountains surface again east of Barcelona, with the Cordillera de la Costa Oriental forming steep shorelines along the Araya and Paria peninsulas and along the north coast of Trinidad.

The easternmost part of Venezuela consists of a swampy lowland, comprising the deltas of the Orinoco, Guanipa, San Juan, and other streams flowing into the Gulf of Paria and Atlantic Ocean; extensive mangrove forests are found along these coasts. To the south and east of the Orinoco River lie the Guyana Highlands; this extensive mountainous area of ancient rocks forms part of the Precambrian Guyana Shield, one of the basic morphostructural units of the South American continent. The Llanos lie in the large basin formed between the Guyana Highlands and the Andean ranges and are composed of sediments deposited by rivers and streams. The area consists of extremely flat grassy savannahs subject to extensive seasonal inundation, and much of it lies below 200 m in altitude.

6.2. Shorebird and habitat distribution

The numbers of Nearctic shorebirds seen in February 1982 are summarized for eco-units in Venezuela by size class in Table 6.1 and by species in Table 6.2*a–c*. Venezuela supported a total of about 130 000 Nearctic shorebirds, representing 4.5% of the South American total. Of the Venezuelan total, 94 500 (72.8%) were classified as small, 32 500 (25.0%) as medium-sized, and 1400 (1.1%) as large, comprising 4.1, 7.1, and 1.2% of the South American size-class totals, respectively (Table 6.1). A further 1400 (1.1%) shorebirds were not classified by size.

Although of moderate importance on a continental scale, the Venezuelan coast held regionally important totals for a number of groups and/or species. The 69 200 peeps found in the Orinoco eco-unit represented 3.3% of the North Coast total and was the largest concentration on the north coast west of the major wintering areas in the Guianas. The Orinoco delta also held regionally important numbers of Sanderlings *Calidris alba* (460, 10.5% of the North Coast total), and this species was also observed regularly on the beaches of western Venezuela (Table 6.2*a*). The only large flock of Red Knot *C. canutus* (520, 5.9% of the North Coast total) identified on the north coast outside northern and north-central Brazil was found in the saline lagoon areas at the mouth of the Lake Maracaibo channel. The long beaches running westwards along the Gulf of Venezuela from this area were not surveyed for security reasons; large numbers of knots (1000+) have been reported from this locality (Casler and Lira 1979). The lagoons of the north-central coast of Venezuela held substantial numbers of dowitchers *Limnodromus* spp. (7100, 15.0% of the North Coast total), which were also relatively numerous along the coastlines of the Orinoco delta (3100, 6.5% of the North Coast total).

6.3. West Caribbean eco-unit

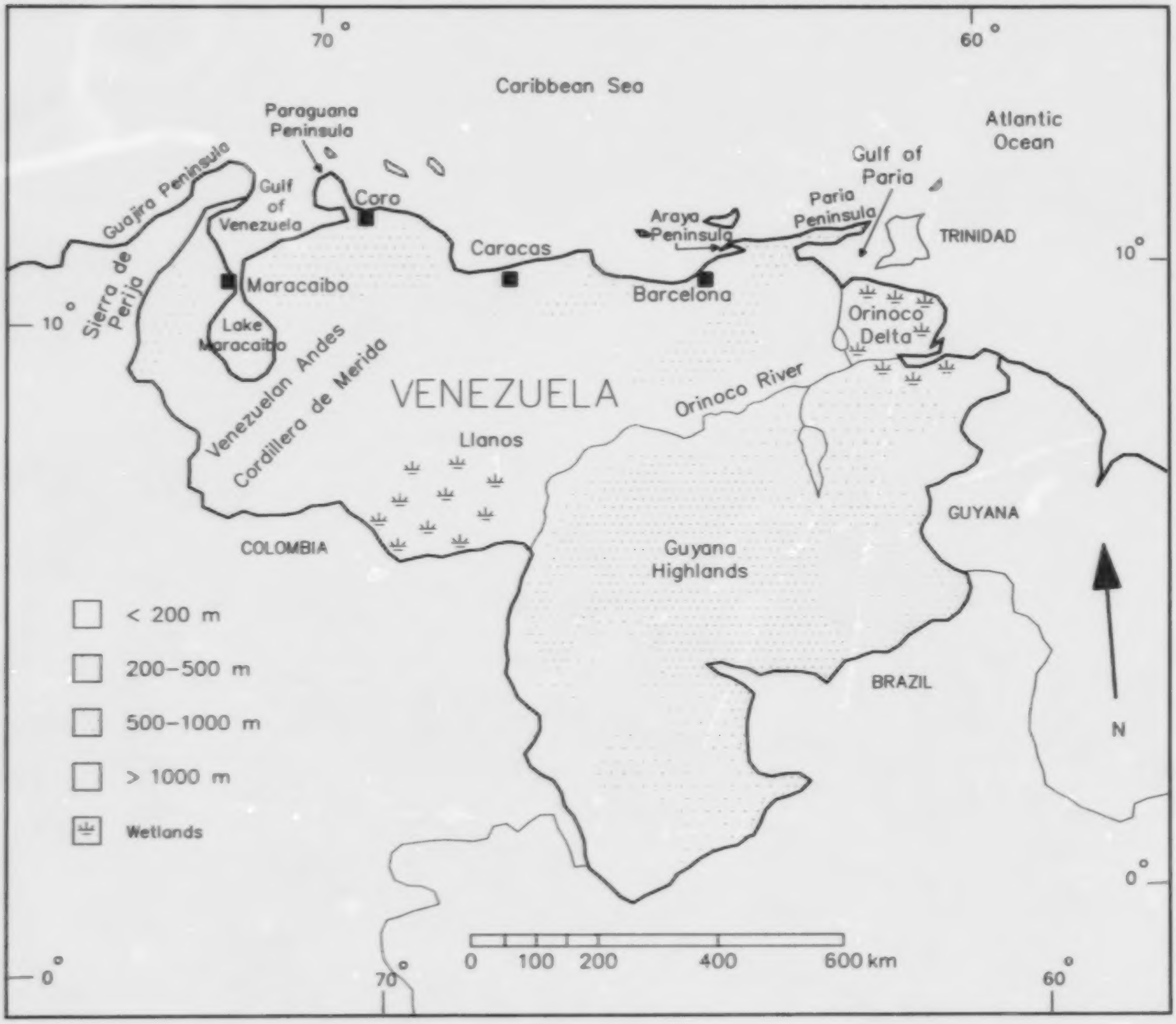
Sectors 1–45; Maps 6.1 (Venezuela-1) and 6.2 (Venezuela-2)

6.3.1. Lake Maracaibo

Sectors 1–19; Map 6.1 (Venezuela-1)

Lake Maracaibo, with an area of some 14 200 km^2 (Fairbridge 1968), occupies approximately one-quarter of the Maracaibo Basin, a low-lying depression bordered to

Figure 6.1
Some of the main geographical features of Venezuela


70°
60°
10°
0°
Caribbean Sea
Atlantic Ocean
Paraguana Peninsula
Guajira Peninsula
Gulf of Venezuela
Coro
Gulf of Paria
Paria Peninsula
TRINIDAD
Araya Peninsula
Caracas
Barcelona
Maracaibo
Sierra de Perija
Lake Maracaibo
Venezuelan Andes
Cordillera de Merida
Orinoco Delta
Orinoco River
VENEZUELA
Llanos
COLOMBIA
GUYANA
Guyana Highlands
BRAZIL
N
< 200 m
200–500 m
500–1000 m
> 1000 m
Wetlands
0
100
200
400
600 km

the west by the mountains of the Sierra de Perija running along the border with Colombia, and to the south and east by the Cordillera de Merida, part of the main branch of the Venezuelan Andes (Fig. 6.1). It is the largest lake in South America, being some 155 km long and over 120 km wide. The lake is generally quite shallow, much of it less than 30 m, with a maximum depth of 35 m. A channel some 55 km long, 3–11 km wide, and 15 m deep joins the lake to the Caribbean Sea. The waters of the lake are somewhat brackish; about 95% of the lake water is derived from precipitation on its watershed and its own surface (Redfield, in Fairbridge 1968). The high temperature of the lake (29–31°C), rapid recycling of nutrients released by plant decomposition in the deeper waters, and strong sunlight make the lake exceptionally productive (Redfield 1958). Tides within the lake are minimal, being only about 1.5 cm at the north and about 6 cm at the south. Water circulation is counterclockwise, presumably owing to the prevailing winds (Redfield 1961), and wind-induced water movements are generally greater than those produced by astronomical tides.

Much of the Maracaibo Basin itself is heavily forested and is seasonally inundated in its southern parts, where annual rainfall is highest. Rainfall decreases steadily from the mountains northwards to the coast, with habitats ranging from humid tropical forest to dry tropical scrub or desert at the shore: the southern part of the lake lies within the tropical rain belt, the northern in a semiarid region.

The northwest shoreline of Lake Maracaibo (Sectors 1–5) is generally rather sandy (Redfield 1958), much of the shore consisting of a narrow sandy beach or margin, with occasional muddy patches; it is lined with palms or a border of trees, behind which lies a mixture of open scrubland, agricultural land, and marshy sloughs and ponds (Table 6.4). Small numbers of shorebirds were found in the ponds (Table 6.3), including peeps, yellowlegs *Tringa* spp., and Black-necked Stilts *Himantopus mexicanus*, as well as moderate numbers of ducks, particularly Blue-winged Teal *Anas discors* (Morrison *et al.* 1985; unpubl. results). Occasional patches of shiny mud occurred along the shore, particularly in Sectors 4 and 5, and the moderate numbers of small shorebirds recorded were usually found in such areas. The most notable feature of this stretch of coast was the very large numbers of Neotropical Cormorants found in the trees all along the northwestern shore of the lake: counts totalled over 48 000 and 39 000 in March 1981 and February 1982, respectively (Morrison *et al.* 1985), reflecting the high productivity of the lake waters.

Very heavy oil pollution was evident along many parts of the southwestern shore of the lake (Sectors 6–10), especially in Sectors 6, 8, and 10; this shore appears to be particularly vulnerable to such pollution owing to the prevailing northeasterly winds and the counterclockwise circulation of the water. An extensive series of lagoons and inlets has built up along this section of the coast where the Rio Catatumbo and other rivers enter the lake, and several long, vegetated channels have been built out into the lake where the main river channels enter. Few shorebirds were found along this section of the lake. Extensive savannahs stretch inland, although the shoreline becomes more heavily forested towards the southern part of the lake. Few shorebirds were seen along the southern or the eastern shores of the lake, the occasional flock of peeps being found on small areas of mud built out from the usually narrow sandy border of the lake. The northeastern shore of Lake Maracaibo was not surveyed owing to the heavy urban and oil developments all along the coast.

6.3.2. West shores of Gulf of Venezuela/ Tablazo Bay

The western shores of the Gulf of Venezuela and of Tablazo Bay were not surveyed, as permission was not given to fly in these areas. The western part of Tablazo Bay contained mangrove stands and swamps and is likely to have contained significant numbers of shorebirds, judging from the numbers seen on the eastern side (see below). The Venezuelan coast of the Guajira Peninsula is situated in an area of intensive uplift and consists of cemented gravel cliffs up to 6 m high, cut back by wave action, with intervening shallow bays and gravel beach ridges and dunes (Ellenberg 1985). The western edge of the Gulf of Venezuela north of Maracaibo consists of a well-developed beach ridge plain, with some 50 to 100 beach ridges tending in a northwest–southeast direction, backed by swamps. The longshore current is strong in this area, and the coast runs at right angles to the direction of the prevailing northeasterly winds, indicating that the sediments are most likely derived from the shallow offshore bottom of the Gulf of Venezuela (Tanner 1971). This area appears to be used by considerable numbers of Nearctic shorebirds, especially during migration, when up to 1700 Red Knots have been reported from the area (Casler and Lira 1979): the more common species included Black-bellied Plovers *Pluvialis squatarola*, Ruddy Turnstones *Arenaria interpres*, Red Knots, Sanderlings, and peeps.

6.3.3. Strait of Maracaibo/Tablazo Bay

Sector 20; Map 6.1 (Venezuela-1)

The narrow entrance to Lake Maracaibo through the Strait of Maracaibo is bounded by faults, and the topography suggests that the strait represents an old river course that has been flooded by the postglacial rise in sea level (Redfield 1958).

The eastern shore of the strait contained little shorebird habitat, and the surveys started on the eastern shore of Tablazo Bay, behind which stretched an enormous area of salinas. The outer part of the bay is heavily fringed with mangroves, and it was in these areas behind the outer ocean beach that concentrations of small and medium-sized shorebirds were found, including 520 Red Knots (Table 6.3), the largest number of this species found on the north coast outside north-central Brazil.

6.3.4. South shore of Gulf of Venezuela/ Paraguana Peninsula

Sectors 21–35; Map 6.1 (Venezuela-1)

Most of the southern shore of the Gulf of Venezuela between the entrance to Lake Maracaibo and the Gulf of Coro consists of sandy beaches, backed by partially vegetated dunes or low cliffs leading inland to a vast scrubby desert, rising to the Segovia Lowlands (up to 1200 m). The whole area is very dry, with annual rainfall not exceeding a few centimetres. The plain consists of marine accumulations and alluvial deposits, with dunes and Pleistocene gravel terraces. The gulf waters are very shallow (10–20 m), and the westwards longshore current weak, particularly towards the Gulf of Coro; there is little wave action.

Some 3000 years ago, uplift of the seafloor resulted in the former island of Paraguana becoming attached to the mainland (Bryan 1973), forming what is now the Paraguana Peninsula, which is connected to the mainland by the Isthmus of Medanos. The resulting enclosure of the Gulf of Coro and diversion of the longshore drift around the Paraguana Peninsula has led to the shallow (up to 8 m) waters of the Gulf of Coro becoming hypersaline and to the formation of an extensive delta (some 450 km^2) by the Rio Mitare. Sediment is supplied for some three months of the year to the delta in this semiarid region, and rapid progradation occurs in the sheltered gulf, with the longshore drift and prevailing winds producing extensive point formations (e.g., Punta Caiman) with sandy eastern flanks and mudflat and mangrove complexes on their western sides. These areas provided the most notable shorebird habitats on this part of the coast (see below). Crescent-shaped dunes migrate across the desert at the base of the isthmus.

Beaches occur all along the east side of the Isthmus of Medanos and the southern half of the east shore of the Paraguana Peninsula and are protected from erosion from the heavy surf by a ledge of beachrock. Several saline lagoons are found in the flat-lying limestone areas inland from the shore on the east coast, and these held significant numbers of shorebirds (Sectors 31 and 33; Table 6.3). The west and north shores of the peninsula were basically sandy with rocky outcrops and a scrubby hinterland; some progradation occurs on the north coast through movement of dunes (Ellenberg 1978, 1985). On the south shore, some tough mudbanks backed by sandy beaches fronted the Gulf of Coro. Heavy urban development occurred around the Punta Fijo area in the southwest of the peninsula, and this area was not surveyed.

Small numbers of shorebirds occurred along the sandy beaches of the south shore of the Gulf of Venezuela. Sanderlings occurred in small numbers on sandy beach habitats, whereas other species, such as peeps, yellowlegs, and other medium-sized species, occurred mostly in small

Table 6.1
Summary totals of Nearctic shorebirds in eco-units in Venezuela

Eco-unit/Parameter	Eco-unit (length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Unclassified shorebirds	Total shorebirds
West Caribbean	1 113.2					
No. of birds		9 640	10 205	406	1 411	21 662
% of size-class total (Venezuela)		10.2	31.4	28.9	100	16.7
% of size-class total (South America)		0.41	2.23	0.33	10.77	0.74
% of size-class total (North Coast)		0.46	3.05	0.67	10.93	0.87
% of grand total (North Coast)		0.39	0.41	0.02	0.06	0.87
Central Caribbean	275.6					
No. of birds		15 203	8 240	519	0	23 962
% of size-class total (Venezuela)		16.1	25.4	36.9	0	18.5
% of size-class total (South America)		0.65	1.80	0.43	0.00	0.82
% of size-class total (North Coast)		0.73	2.46	0.86	0.00	0.96
% of grand total (North Coast)		0.61	0.33	0.02	0.00	0.96
Orinoco	549.2					
No. of birds		69 633	14 028	480	0	84 141
% of size-class total (Venezuela)		73.7	43.2	34.2	0	64.8
% of size-class total (South America)		2.99	3.07	0.40	0.00	2.88
% of size-class total (North Coast)		3.33	4.19	0.79	0.00	3.37
% of grand total (North Coast)		2.79	0.56	0.02	0.00	3.37
All Venezuela	1 938.0					
No. of birds		94 476	32 473	1 405	1 411	129 765
% of size-class total (North Coast)		4.52	9.69	2.32	10.93	5.20
% of size-class total (South America)		4.06	7.10	1.16	10.77	4.45
% of grand total (South America)		3.24	1.11	0.05	0.05	4.45

Table 6.2*a*
Totals of Nearctic shorebird species in eco-units in Venezuela—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
West Caribbean	1 113.2				
No. of birds		10	194	9 436	9 640
% of species total (North Coast)		2.78	4.44	0.45	0.46
% of species total (South America)		2.32	0.17	0.43	0.41
% of size-class total (North Coast)		0.00	0.01	0.45	0.46
% of grand total (North Coast)		0.00	0.01	0.38	0.39
Central Caribbean	275.6				
No. of birds		1	0	15 202	15 203
% of species total (North Coast)		0.28	0.00	0.73	0.73
% of species total (South America)		0.23	0.00	0.69	0.65
% of size-class total (North Coast)		0.00	0.00	0.73	0.73
% of grand total (North Coast)		0.00	0.00	0.61	0.61
Orinoco	549.2				
No. of birds		7	460	69 166	69 633
% of species total (North Coast)		1.94	10.53	3.32	3.33
% of species total (South America)		1.62	0.41	3.13	2.99
% of size-class total (North Coast)		0.00	0.02	3.31	3.33
% of grand total (North Coast)		0.00	0.02	2.77	2.79
All Venezuela	1 938.0				
No. of birds		18	654	93 804	94 476
% of species total (South America)		4.18	0.58	4.24	4.06
% of size-class total (South America)		0.00	0.03	4.03	4.06
% of grand total (South America)		0.00	0.02	3.21	3.24

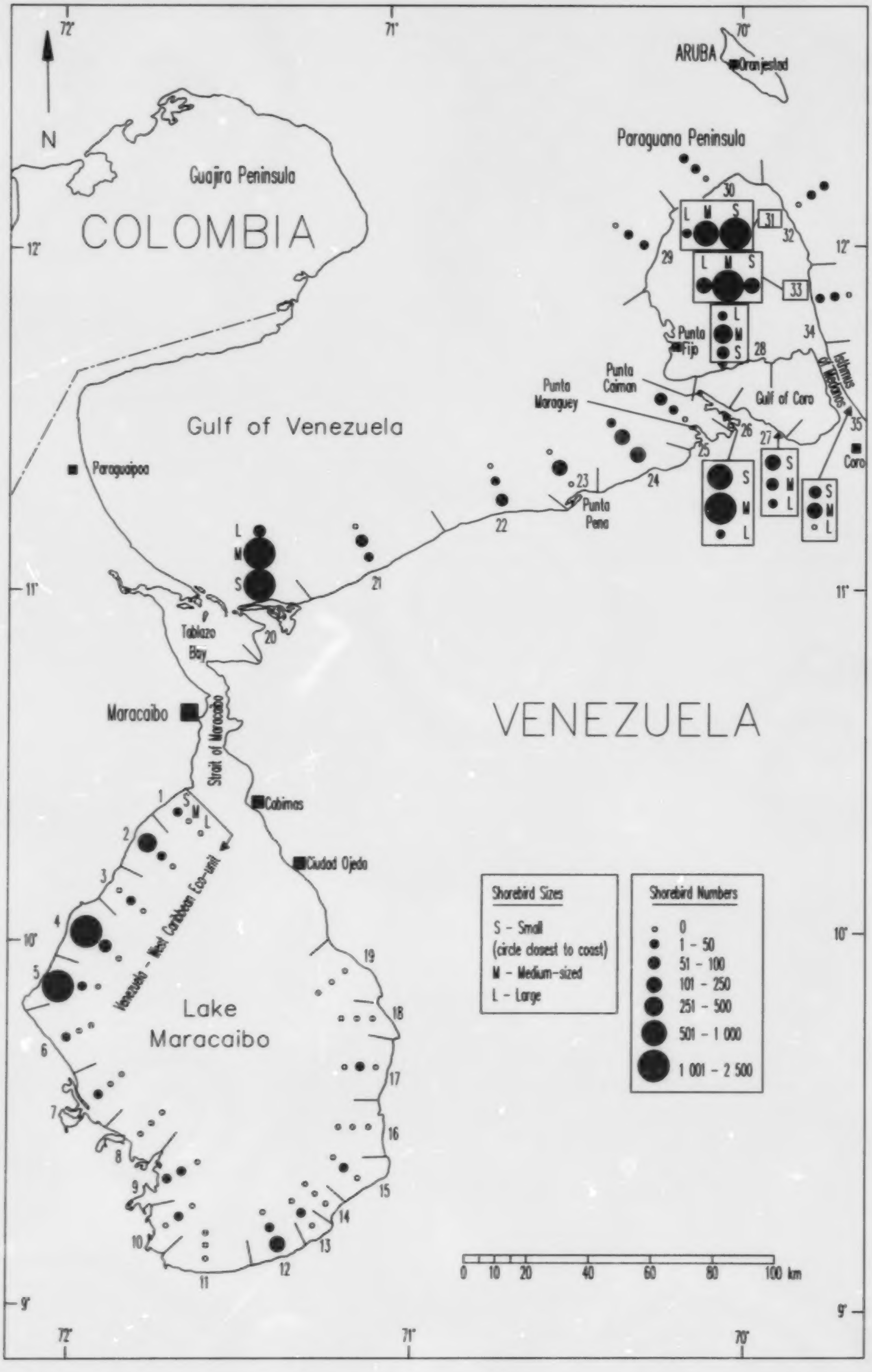
Table 6.2b
Totals of Nearctic shorebird species in eco-units in Venezuela—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Red Knot	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
West Caribbean	1 113.2							
No. of birds		212	219	1 290	520	0	7 964	10 205
% of species total (North Coast)		0.89	1.08	1.56	5.88	0.00	5.24	3.05
% of species total (South America)		0.78	0.93	1.42	0.68	0.00	4.29	2.23
% of size-class total (North Coast)		0.06	0.07	0.38	0.16	0.00	2.38	3.05
% of grand total (North Coast)		0.01	0.01	0.05	0.02	0.00	0.32	0.41
Central Caribbean	275.6							
No. of birds		48	0	779	0	7 113	300	8 240
% of species total (North Coast)		0.20	0.00	0.94	0.00	15.00	0.20	2.46
% of species total (South America)		0.18	0.00	0.85	0.00	14.56	0.16	1.80
% of size-class total (North Coast)		0.01	0.00	0.23	0.00	2.12	0.09	2.46
% of grand total (North Coast)		0.00	0.00	0.03	0.00	0.28	0.01	0.33
Orinoco	549.2							
No. of birds		143	42	308	0	3 100	10 435	14 028
% of species total (North Coast)		0.60	0.21	0.37	0.00	6.54	6.87	4.19
% of species total (South America)		0.52	0.18	0.34	0.00	6.34	5.62	3.07
% of size-class total (North Coast)		0.04	0.01	0.09	0.00	0.93	3.11	4.19
% of grand total (North Coast)		0.01	0.00	0.01	0.00	0.12	0.42	0.56
All Venezuela	1 938.0							
No. of birds		403	261	2 377	520	10 213	18 699	32 473
% of species total (South America)		1.48	1.11	2.61	0.68	20.90	10.07	7.10
% of size-class total (South America)		0.09	0.06	0.52	0.11	2.23	4.09	7.10
% of grand total (South America)		0.01	0.01	0.08	0.02	0.35	0.64	1.11

Table 6.2c
Totals of Nearctic shorebird species in eco-units in Venezuela—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Unidentified large shorebird species	Total large shorebirds
West Caribbean	1 113.2				
No. of birds		114	121	171	406
% of species total (North Coast)		0.75	0.31	2.96	0.67
% of species total (South America)		0.46	0.27	2.62	0.33
% of size-class total (North Coast)		0.19	0.20	0.28	0.67
% of grand total (North Coast)		0.00	0.00	0.01	0.02
Central Caribbean	275.6				
No. of birds		5	464	50	519
% of species total (North Coast)		0.03	1.17	0.87	0.86
% of species total (South America)		0.02	1.05	0.76	0.43
% of size-class total (North Coast)		0.01	0.76	0.08	0.86
% of grand total (North Coast)		0.00	0.02	0.00	0.02
Orinoco	549.2				
No. of birds		207	273	0	480
% of species total (North Coast)		1.36	0.69	0.00	0.79
% of species total (South America)		0.83	0.62	0.00	0.40
% of size-class total (North Coast)		0.34	0.45	0.00	0.79
% of grand total (North Coast)		0.01	0.01	0.00	0.02
All Venezuela	1 938.0				
No. of birds		326	858	221	1 405
% of species total (South America)		1.31	1.93	3.38	1.16
% of size-class total (South America)		0.27	0.71	0.18	1.16
% of grand total (South America)		0.01	0.03	0.01	0.05

Map 6.1 (Venezuela-1)
Distribution of Nearctic shorebirds on the northwestern coast of Venezuela


N
72°
71°
70°
12°
11°
10°
9°
ARUBA
Oranjestad
Paraguana Peninsula
Guajira Peninsula
COLOMBIA
Gulf of Venezuela
Paraguaipoa
Punta Fijo
Punta Caiman
Punta Maraguey
Punta Pena
Gulf of Coro
Isthmus of Medanos
Coro
Tablazo Bay
Maracaibo
Strait of Maracaibo
Cabimas
Ciudad Ojeda
VENEZUELA
Lake Maracaibo
Venezuela - West Caribbean Eco-unit
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21
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28
29
30
31
32
33
34
35
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
0
10
20
40
60
80
100 km

Table 6.3
Totals of Nearctic shorebirds in survey sectors in Map 6.1 (Venezuela-1)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Red Knot	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Unclas-sified shore-birds	Total shore-birds
1	10.0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
2	23.8	0	0	465	465	0	0	20	0	0	20	0	0	0	0	1 200	1 685
3	13.0	0	0	0	0	0	0	22	0	0	22	0	0	0	0	0	22
4	22.1	0	0	1 030	1 030	0	0	48	0	10	58	0	0	0	0	0	1 088
5	27.3	0	0	1 021	1 021	0	0	5	0	1	6	0	0	0	0	0	1 027
6	27.6	8	0	0	8	0	0	0	0	0	0	0	0	0	0	0	8
7	15.8	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
8	25.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	17.8	0	0	15	15	0	0	0	0	1	1	0	0	0	0	0	16
10	19.0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
11	29.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	22.2	0	0	200	200	0	0	24	0	0	24	0	0	0	0	0	224
13	11.4	0	0	0	0	0	0	1	0	10	11	0	0	0	0	0	11
14	10.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	23.0	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	6
16	19.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	22.2	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1
18	13.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	15.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	42.5	0	0	2 320	2 320	8	2	34	520	926	1 490	23	22	0	45	200	4 055
21	48.2	0	34	0	34	0	0	6	0	60	66	0	0	0	0	7	107
22	45.4	0	15	50	65	0	0	4	0	20	24	0	0	0	0	0	89
23	22.4	0	0	0	0	0	0	0	0	105	105	0	0	0	0	0	105
24	42.0	0	4	200	204	0	0	52	0	74	126	1	1	1	3	0	333
25	42.1	0	0	0	0	0	0	50	0	0	50	5	60	0	65	0	115
26	45.9	0	10	530	540	5	0	13	0	1 546	1 564	22	8	0	30	2	2 136
27	33.2	0	47	135	182	26	1	0	0	66	93	20	0	0	20	0	295
28	24.4	0	0	90	90	0	2	0	0	344	346	12	0	0	12	0	448
29	30.9	0	0	30	30	0	0	0	0	25	25	0	0	0	0	0	55
30	33.9	0	0	0	0	0	2	0	0	5	7	7	0	0	7	0	14
31	0.0	0	0	2 320	2 320	1	0	31	0	540	572	22	0	6	28	0	2 920
32	32.4	0	0	0	0	0	0	0	0	1	1	0	0	4	4	0	5
33	0.0	0	0	250	250	0	0	0	0	2 130	2 130	0	0	160	160	0	2 540
34	27.7	0	19	0	19	2	36	0	0	0	38	0	0	0	0	2	59
35	29.5	0	55	30	85	0	176	0	0	0	176	0	0	0	0	0	261
Total	868.9	10	184	8 686	8 880	42	219	318	520	5 864	6 963	112	91	171	374	1 411	17 628

Table 6.4
Principal habitats in survey sectors in Map 6.1 (Venezuela-1)

Sector no.	Habitat description
1	Freshwater lakeshore; narrow sand beach / palms / grassland, sloughs
2	Freshwater lakeshore; narrow sand beach / palms / grass, scrub, sloughs
3	Freshwater lakeshore; narrow sand beach / palms / grass, scrub, sloughs
4	Freshwater lakeshore; narrow sand beach / palms, scrub / grassland, marsh, forest
5	Freshwater lakeshore; narrow sand- and mudflats / forest, scrub / grassland, marsh, forest
6	Freshwater lakeshore; narrow sand- and mudflats / forest
7	Freshwater lakeshore; estuary, marshy shore / forest
8	Freshwater lakeshore; estuary, sand beach and spits / scrub, grassland, marsh / forest
9	Freshwater lakeshore; estuary, some small sandflats / grassland, marsh / forest
10	Freshwater lakeshore; narrow sandy shore / forest, scrub / forest, grassland
11	Freshwater lakeshore; narrow sand- and mudflats / scrub / forest, grassland
12	Freshwater lakeshore; narrow sand- and mudflats / forest, marsh
13	Freshwater lakeshore; sandy river mouth, some flats / forest / marsh
14	Freshwater lakeshore; narrow sand beach / palms, scrub / forest, marsh
15	Freshwater lakeshore; narrow sand beach and spits / palms / forest, scrub
16	Freshwater lakeshore; narrow sand beach / palms / scrub, forest
17	Freshwater lakeshore; narrow sand beach / marsh, scrub / scrubby forest
18	Freshwater lakeshore; narrow sand beach with bars / thick scrub / scrub, marsh, forest
19	Freshwater lakeshore; narrow sand beach with bars / thick scrub / scrub, marsh, forest
20	Narrow sand beach fronting broad mudflats with mangroves / dunes / salt pans, scrub
21	Narrow sand beach / dunes, cliffs / scrubby desert
22	Narrow sand beach / cliffs / scrubby desert
23	Narrow sand beach, spits with some mudflats / cliffs / scrubby desert
24	Narrow beach, some mudflats / cliffs, dunes / scrubby desert
25	Mudflats and mangroves with some sand beach / scrubby desert
26	Broad mudflats with mangroves, some sand beach / dunes / scrubby desert
27	Narrow sand beach, some mudbanks / dunes / sandy desert
28	Tough mudbanks backed by narrow sand beach / dunes / sandy desert, scrub
29	Narrow sand beach / dunes / scrubby desert with lagoon
30	Narrow sand beach, some rock outcrops / dunes / scrubby desert
31	Inland; saline lagoon / scrubby desert
32	Shelving rocky beach / scrubby desert, salt pans
33	Inland; saline lagoon / scrubby desert
34	Narrow sand beach / road / scrubby desert, salt pans
35	Narrow sand beach, rocky shelves / road / sandy desert

muddy pans formed behind sandy spits. The largest concentrations occurred around the delta of the Rio Mitare, especially on the sandy mudflats and mangrove areas on the west side of Punta Caiman (Sector 26), where moderately large numbers of small and medium-sized species were found, including peeps (530), medium-sized species (1600) such as Black-bellied Plovers and yellowlegs, and smaller numbers of large species, including Whimbrels *Numenius phaeopus* and Willets *Catoptrophorus semipalmatus*. The salinas on the east side of the Paraguana Peninsula also held locally significant numbers of birds, with 2900 shorebirds, mostly small species, in the northern area (Sector 31) (Salinas de Bajarigua), and another 2500, mostly medium-sized species, in the southern area (Sector 33) (Table 6.3). A colony of frigatebirds (approx. 1500 birds) was discovered on Punta Maraguey.

6.3.5. Coro to Puerto Cabello

Sectors 36–45; Map 6.2 (Venezuela-2)

Very few shorebirds were seen on the coast between the Coro area and Chichiriviche (Sectors 36, 37, 39, and 41), the only observations being of Black-bellied Plovers near the Isthmus de Medano on the beaches just past La Vela de Coro (Sector 36) (Table 6.5). There is little suitable shorebird habitat on the coast. The area between La Vela de Coro and Punta Aguide is hilly, consisting of horizontally bedded Oligocene and Miocene soft sediments, with steep and cliffed coastal slopes; some intervening bays have more recent sediments.

The most significant shorebird (and waterfowl) habitats are found in the lagoons behind the coast. The lagoons near Campechano (Sector 38; Table 6.6) held over 3200 shorebirds, mostly peeps, yellowlegs, and other medium-sized species. Although no Nearctic shorebirds were recorded on the lagoons near Sauca (Sector 40) in February 1982, the lagoons are used periodically by migrants, 1000 medium-sized shorebirds having been recorded there in March 1981 (unpubl. results).

The coast is somewhat lower-lying north and south of San Juan de los Cayos, which is protected by a fringing reef. Longshore currents flow north and westwards around the coast, carrying sediments from, for instance, the Rio Tocuyo. Behind the coastal beach ridge lie salt lagoons, and those in the vicinity of and to the south of San Juan de los Cayos in the Rio Tucurere area and towards the Laguna Tacarigua (Sector 42) held moderate numbers of medium-sized species. Nearctic shorebirds were not noted among the large numbers of other species found in the parts of the Chichiriviche complex that were surveyed in February 1982, although they were recorded in this area in March 1981 (Morrison *et al.* 1985). These lagoons were also of very considerable importance for waterfowl, particularly Blue-winged Teal, American Wigeon *Anas americana*, whistling-ducks *Dendrocygna* spp., and flamingos *Phoenicopterus ruber* (Morrison *et al.* 1985).

No Nearctic shorebirds were noted in the outer parts of the mangrove-lined bays south of Punta Tucacas (Sector 44). Small numbers were found on the sandy beaches running south from Tucacas (Sector 45).

The Cordillera de la Costa runs along the coast from the Moron/Puerto Cabello area, resulting in a steep, mountainous coastline eastwards to Punta los Indios. No surveys were carried out on this stretch owing to the lack of suitable shorebird habitat.

6.4. Central Caribbean eco-unit

Sectors 46–57; Map 6.3 (Venezuela-3)

Along the shore of the Caribbean Sea from Higuerote to Barcelona there is a narrow strip of coastal plain that represents a Recent or Pleistocene seafloor. This plain also occurs in various places along the north coast of the northeastern mountains, in particular around Cumana and east of Cariaco, where it forms the Cariaco depression between the Serrania del Interior and the Serrania del Costa. The coastal plain contains many broad lagoons and salt marshes and is very wet and extensively inundated during rainy seasons. Recent marine shells less than a metre above the present sea level, as well as the physiographic setting, indicate that the area was recently part of a seafloor (Hedberg 1950). Progradation of the coast may be occurring between Higuerote and Barcelona, owing to sedimentation and slow tectonic uplift (Ellenberg 1978), although areas farther east are thought to be subsiding (Ellenberg 1985).

The lagoons of the coastal plains of north-central Venezuela provide some of the most important shorebird habitat in the country. These lagoons not only are important for Nearctic shorebirds, but are also used by large numbers of other aquatic birds (Morrison *et al.* 1985; Scott and Carbonell 1986).

Most of the shoreline between Higuerote and Barcelona consists of straight, sandy ocean beaches; very few shorebirds were seen on these habitats.

The Laguna de Tacarigua (Sector 48) contained only small concentrations of shorebirds (Table 6.7), most of which were found on the muddy areas in the open thickets on the spit between the lagoon itself and the ocean beach. Much of the west end and interior parts of the lagoon contained relatively deep water without muddy margins.

The majority of the shorebirds found on the Laguna de Unare (Sector 50) and Laguna de Piritu (Sector 52) also occurred on the muddy margins of the lagoon along the spit/sand barrier separating the lagoon from the sea (Table 6.8). Moderate numbers (2000) of shorebirds occurred on the Laguna de Unare. Substantial numbers were found on the Laguna de Piritu; the total of 10 300 represented some 43.0% of the shorebirds on the Central Caribbean eco-unit and included 9700 small shorebirds, representing 63.5% of the birds in that category. These lagoons also appear to be used heavily during migration. Over 67 000 small shorebirds were counted on the Laguna de Piritu during surveys in March 1981, and Altman (in Scott and Carbonell 1986) recorded a maximum count total of over 78 500 Nearctic shorebirds at the Laguna de Unare, including 75 000 small shorebirds. The importance of these lagoons is underlined by the large numbers of other aquatic birds using them, including cormorants, pelicans, ducks, and flamingos (Morrison *et al.* 1985; Scott and Carbonell 1986).

Moderate numbers (3800) of shorebirds were found in the saline lagoon areas west of Barcelona (Sector 54)—these areas contained extensive wetlands, which appeared to be subject to seasonal flooding.

The Laguna de Chacopata (Sector 55) on the north side of the Araya Peninsula was another very important area, containing both mangrove complexes and shallow areas with wide muddy margins. Most of the 7600 shorebirds were classified as medium-sized, of which 6700 were dowitchers, representing 14.1% of the total for the North Coast. The 440 Willets comprised 50.7% of the total for Venezuela.

Map 6.2 (Venezuela-2)
Distribution of Nearctic shorebirds along the west-central coast of Venezuela

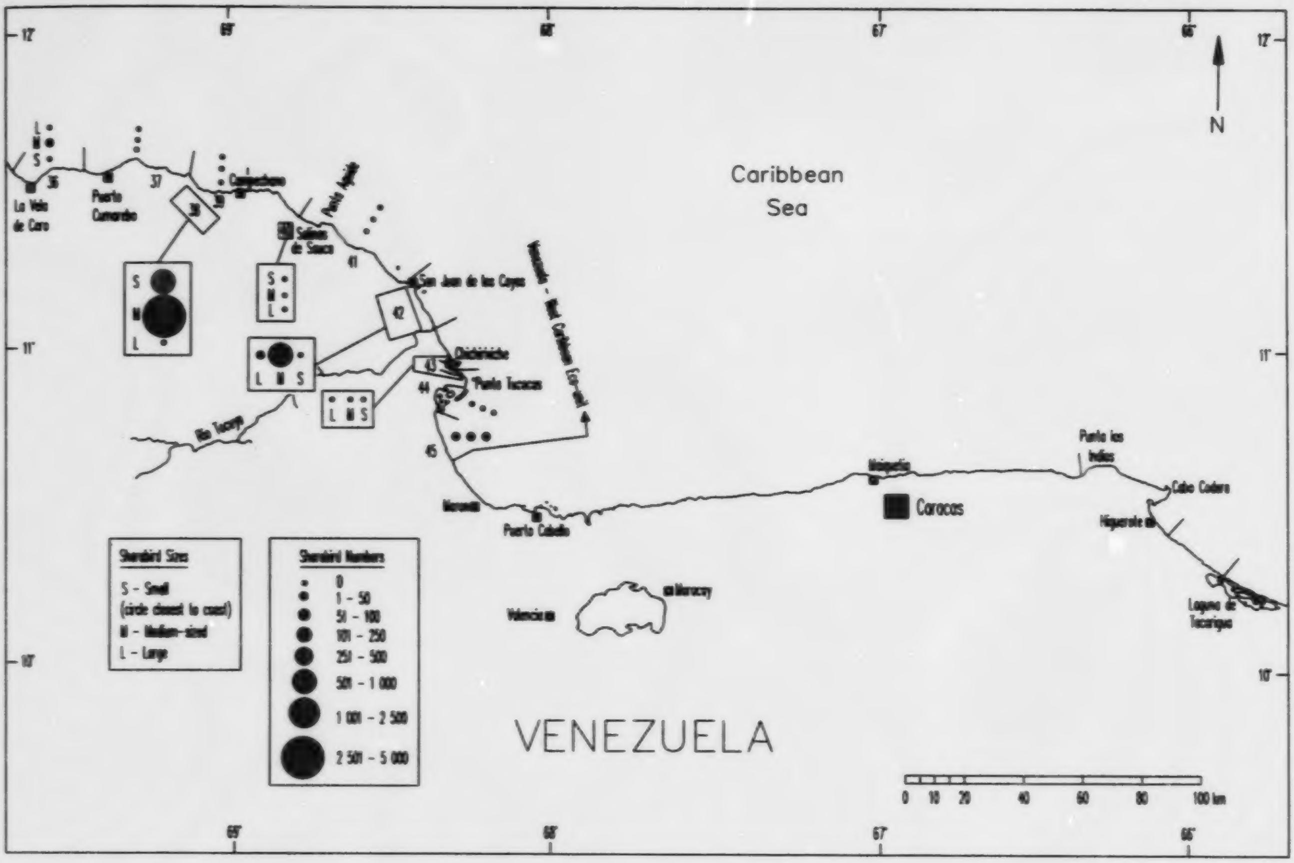

Caribbean Sea
N
VENEZUELA
La Vela de Coro
Puerto Cumarebo
Cuchechero
Punta Aguide
Salinas de Sauca
San Juan de los Cayos
Chichiriviche
Punta Tucacas
Rio Tocuyo
Moron
Puerto Cabello
Valencia
Maiquetia
Caracas
Punta los Indios
Cabo Codera
Higuerote
Laguna de Tacarigua
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
0 10 20 40 60 80 100 km
69°
68°
67°
66°
12°
11°
10°

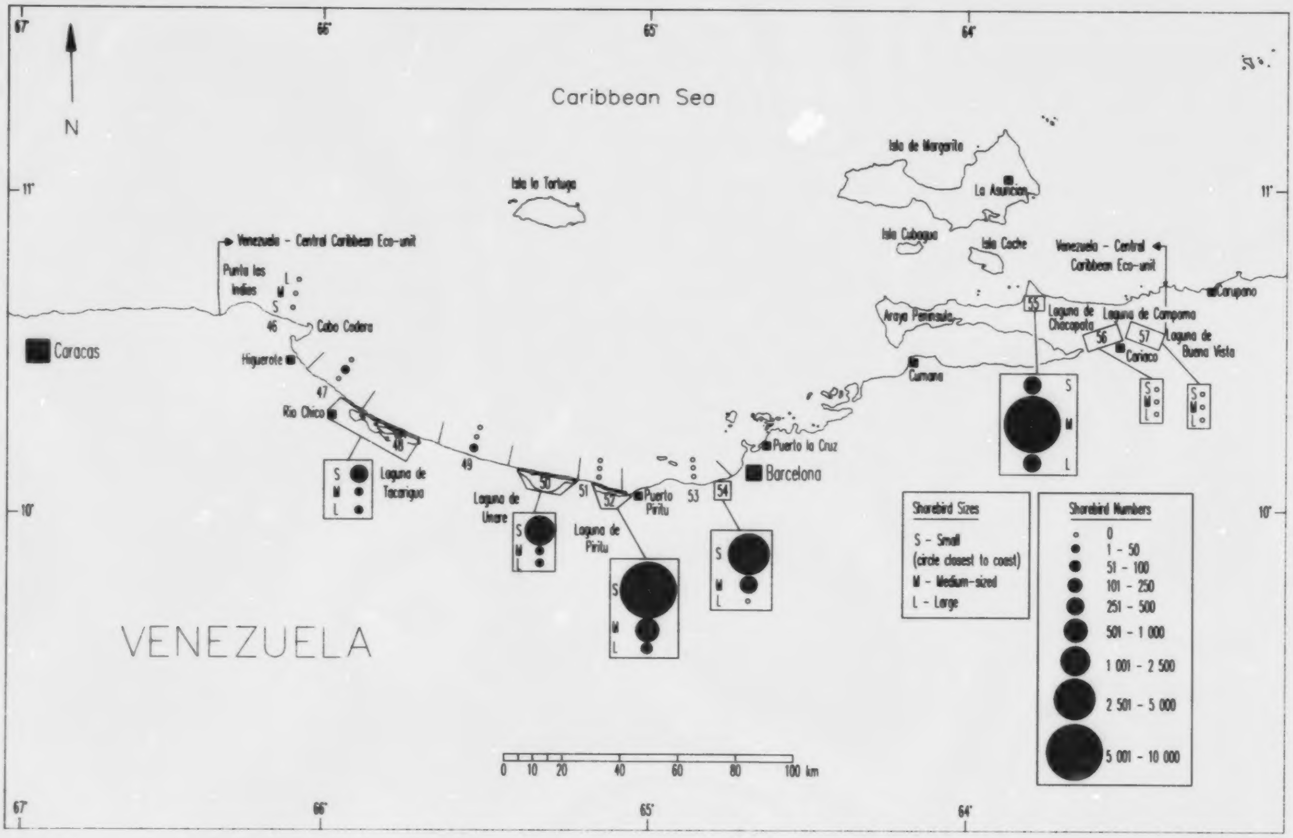
Table 6.5
Totals of Nearctic shorebirds in survey sectors in Map 6.2 (Venezuela-2)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
36	23.0	0	0	0	42	0	0	42	0	0	0	42
37	41.5	0	0	0	0	0	0	0	0	0	0	0
38	37.0	0	730	730	0	881	1 630	2 511	0	0	0	3 241
39	19.6	0	0	0	0	0	0	0	0	0	0	0
40	21.1	0	0	0	0	0	0	0	0	0	0	0
41	52.1	0	0	0	0	0	0	0	0	0	0	0
42	0.0	0	0	0	110	90	470	670	0	30	30	700
43	0.0	0	0	0	0	0	0	0	0	0	0	0
44	27.0	0	0	0	0	0	0	0	0	0	0	0
45	23.0	10	20	30	18	1	0	19	2	0	2	51
Total	244.3	10	750	760	170	972	2 100	3 242	2	30	32	4 034

Table 6.6
Principal habitats in survey sectors in Map 6.2 (Venezuela-2)

Sector no.	Habitat description
36	Narrow sand beach, rocky shelves / dunes / scrubby desert on hills
37	Narrow sand beaches, rocky sections / scrubby hills, some farmland
38	Inland; brackish lagoon, broad mudflats / scrub, farmland
39	Narrow beach, some rocky sections / scrub, farmland
40	Inland; brackish lagoon, broad mudflats / scrub, farmland
41	Narrow sand beach / cultivated palms
42	Inland; freshwater lagoon with marsh, some muddy sections / scrub, cultivated palms
43	Inland; brackish lagoon with large marshy mudflats / scrub, cultivated palms
44	Mangrove-covered islands / forest, cultivated palms
45	Narrow sand beach / cultivated palms, roads and habitations

Map 6.3 (Venezuela-3)
Distribution of Nearctic shorebirds along the east-central coast of Venezuela


Caribbean Sea
N
VENEZUELA
Caracas
Venezuela - Central Caribbean Eco-unit
Punta los Indios
Cabo Codera
Higuerote
Rio Chico
Laguna de Tacarigua
Laguna de Unare
Laguna de Piritu
Puerto Piritu
Puerto la Cruz
Barcelona
Cumana
Isla la Tortuga
Isla de Margarita
La Asuncion
Isla Cubagua
Isla Coche
Araya Peninsula
Laguna de Chacopata
Laguna de Campoma
Laguna de Buena Vista
Cariaco
Carupano
46
47
48
49
50
51
52
53
54
55
56
57
S
M
L
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
0
10
20
40
60
80
100 km
67°
66°
65°
64°
11°
10°

Aerial surveys in March 1981 along the coast between Puerto la Cruz and Cumana and along various parts of the Araya Peninsula revealed little shorebird habitat, and these areas were not resurveyed in February 1982. Other small lagoons occur in the coastal plain sectors of this area (e.g., near Cumana and Chiguana) and are used by moderate numbers of shorebirds both during the winter and during migration (McNeil 1970). No Nearctic shorebirds were observed in the freshwater lagoon systems at the Laguna de Campona (Sector 56) and Laguna de Buena Vista (Sector 57).

6.5. Orinoco eco-unit

Sectors 58–77; Map 6.4 (Venezuela-4)

The Orinoco is one of the largest rivers in the world (van Andel and Postma 1954; Lisitzin 1972). It is some 2560 km in length, and its many tributaries include a number of other long rivers, e.g., the Rio Meta (1100 km), the Rio Apure (675 km), and the Rio Caroni (700 km) (van Andel and Postma 1954). The drainage basin covers some 944 000 km^2, about 35% of which involves the Guyana Shield, another 15% the Andean ranges and Cordillera de la Costa, and the remaining 50% occupied by the vast plains and swamps of the Llanos.

The vast area occupied by the Llanos is extremely flat: elevations do not exceed 200 m, and about one-third of its area is below 100 m. Average stream gradients are often less than 1:15 000, and much of the region is covered by floodplains and swamps, which act as a sediment trap. Little sediment from the Andes, therefore, is likely to reach the Orinoco delta, whereas sediments from the Guyana Shield drain into the lower, swifter-flowing parts of the river and are carried downstream more readily (van Andel and Postma 1954; van Andel 1967). In its upper reaches, the Orinoco actually connects, via the Casiquiare Channel, with the Rio Negro, one of the major Amazon tributaries. The direction of flow in this channel reverses seasonally, depending on the flood stages of the two rivers. Van Andel (1967) pointed out that only a minor regional geological tilting would result in a sizeable portion of the Orinoco drainage being captured by the Rio Negro.

The entire Orinoco delta, or Delta Amacuro, is composed of two relatively distinct parts: the southern section, which fronts the Atlantic Ocean southeast of Trinidad; and the northern section, which forms the Venezuelan coastline of the Gulf of Paria and is sheltered by Trinidad. The Orinoco proper occupies the southern sector, extending from the Boca Grande at the southeastern end, through a pair of distributaries to the Cano Manamo just west of Pedernales. In the northern part, a number of other rivers reach the coast, including the Cano Ajies, Rio San Juan, and Rio Guanipa, which drain the mountainous area of the Serrania del Interior and the Mesas. The embayment occupied by this delta represents the last remnant of the Tertiary Sea of eastern Venezuela, which is currently being filled by sediment. Van Andel

Table 6.7
Totals of Nearctic shorebirds in survey sectors in Map 6.3 (Venezuela-3)

Sector no.	Sector length (km)	Spotted Sand-piper	Uniden-tified small shorebird species	Total small shore-birds	Black-bellied Plover	Yellow-legs species	Dowit-cher species	Uniden-tified medium-sized shorebird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shorebird species	Total large shore-birds	Total shore-birds
46	56.5	0	0	0	0	0	0	0	0	0	0	0	0	0
47	24.0	0	0	0	1	0	0	0	1	0	0	0	0	1
48	66.6	0	252	252	0	21	0	0	21	0	4	0	4	277
49	26.8	1	0	1	0	0	0	0	0	0	0	0	0	1
50	31.1	0	1 960	1 960	7	0	0	0	7	0	20	0	20	1 987
51	36.8	0	0	0	0	0	0	0	0	0	0	0	0	0
52	15.8	0	9 660	9 660	0	465	3	130	598	1	5	50	56	10 314
53	18.0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0.0	0	3 070	3 070	40	270	400	0	710	0	0	0	0	3 780
55	0.0	0	260	260	0	23	6 710	170	6 903	4	435	0	439	7 602
56	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	275.6	1	15 202	15 203	48	779	7 113	300	8 240	5	464	50	519	23 962

Table 6.8
Principal habitats in survey sectors in Map 6.3 (Venezuela-3)

Sector no.	Habitat description
46	Rocky shore with sandy bays / steep hills and cliffs / forest
47	Narrow sand beach / cultivated palms / lagoon, habitations, forest
48	Inland; brackish lagoon with mangroves and some mudflats / forest, farmland
49	Narrow sand beach / cultivated palms / scrub
50	Inland; saltwater lagoon with broad sand- and mudflats / scrubby hills
51	Narrow sand beach / scrub, palms, lagoon
52	Inland; shallow saltwater lagoon with broad sand- and mudflats / scrubby hills
53	Narrow sand beach / cactus scrub on hills
54	Inland; shallow brackish lagoon with broad mudflats / scrub
55	Inland; brackish lagoon, broad mudflats, mangrove / salt pans, scrubby desert
56	Inland; freshwater marsh / forest and hills
57	Inland; freshwater marsh / forest and hills

(1967) commented that in another 5000–10 000 years the Gulf of Paria will be filled in and encroaching on the coast of Trinidad.

Tidal amplitudes at the outer shore range from about 1.6 m at Boca Grande to 1.3 m at Pedernales and 1.4 m at the mouth of the Rio San Juan. Tidal influence extends well upstream, being 0.6 m at Barrancas, where the distributaries diverge. The tidal influence is small compared with the effects of flooding, which produce a 9.4-m range at Barrancas and a 3.6-m range lower in the delta, resulting in much of the lower delta being completely flooded in the high-water season (van Andel 1967).

Offshore, the predominant North Equatorial (Guiana) Current flows northwestwards with a velocity of 50–75 $\mathrm{cm \cdot s^{-1}}$ in the spring, falling to 25–40 $\mathrm{cm \cdot s^{-1}}$ in the autumn (Fuglister 1951; Postma, in van Andel 1967). One branch of the current flows north then westwards around Trinidad, whereas a second branch enters the Gulf of Paria through the Serpent's Mouth off the southwestern coast of Trinidad, where current velocities reach 100 $\mathrm{cm \cdot s^{-1}}$. The current flows northwards along the west side of the Gulf of Paria, so that a clockwise gyre develops on the east side of the gulf off the west coast of Trinidad, and exits through the Dragons' Mouths between the Paria Peninsula and northwestern tip of Trinidad, where current velocities also reach 100 $\mathrm{cm \cdot s^{-1}}$ (van Andel and Postma 1954; van Andel 1967).

Rainfall is heavy, reaching 1857 $\mathrm{mm \cdot yr^{-1}}$ at Pedernales (van der Voorde 1962), with the highest amounts falling from May to October.

Easterly trade winds prevail throughout the year, producing a northwestward longshore drift along the coast of the Guianas and the southern Orinoco delta. This current has produced a conspicuous northwestward bend in the lower courses of all the major rivers and has resulted in the development of sand ridge, or chenier, systems on the northwest banks of present and previous river mouths, which are similar to those found along the coast of the Guianas (Brouwer 1953; Zonneveld 1953, 1954; Bleachley 1956; van der Eyk 1957; Vann 1959). Such structures are particularly common between the Cano Araguao and Cano Manamo.

The Orinoco supplies a large amount of predominantly fine-grained material, estimated at 86.3 × 10^6 $\mathrm{tons \cdot yr^{-1}}$, with a discharge of between 0.44 and 0.54 × 10^{12} $\mathrm{m^3 \cdot yr^{-1}}$ of water (Sanchez 1950; Keller 1962; van Andel 1967; Lisitzin 1972). Less sediment is carried by rivers and streams draining the northwestern part of the delta along the south coast of the Paria Peninsula, and little sedimentation occurs in this area, except in embayments. Little sediment deposition occurs on the west coast of Trinidad as well, except in sheltered nearshore areas (van Andel and Curray 1960; van Andel 1967). Although the southern part of the delta is exposed to the Atlantic swell, the broad offshore platform and high concentrations of sediment tend to dampen wave action (NEDECO 1962). River-borne

Laguna de Piritu, Venezuela. The lagoons of the north-central coast of Venezuela are situated on a narrow coastal plain between mountains and sea and contain some of the most important shorebird habitats in Venezuela. The flat topography results in some of the lagoons having wide, muddy margins, and these lagoons support substantial numbers of wintering Nearctic shorebirds.

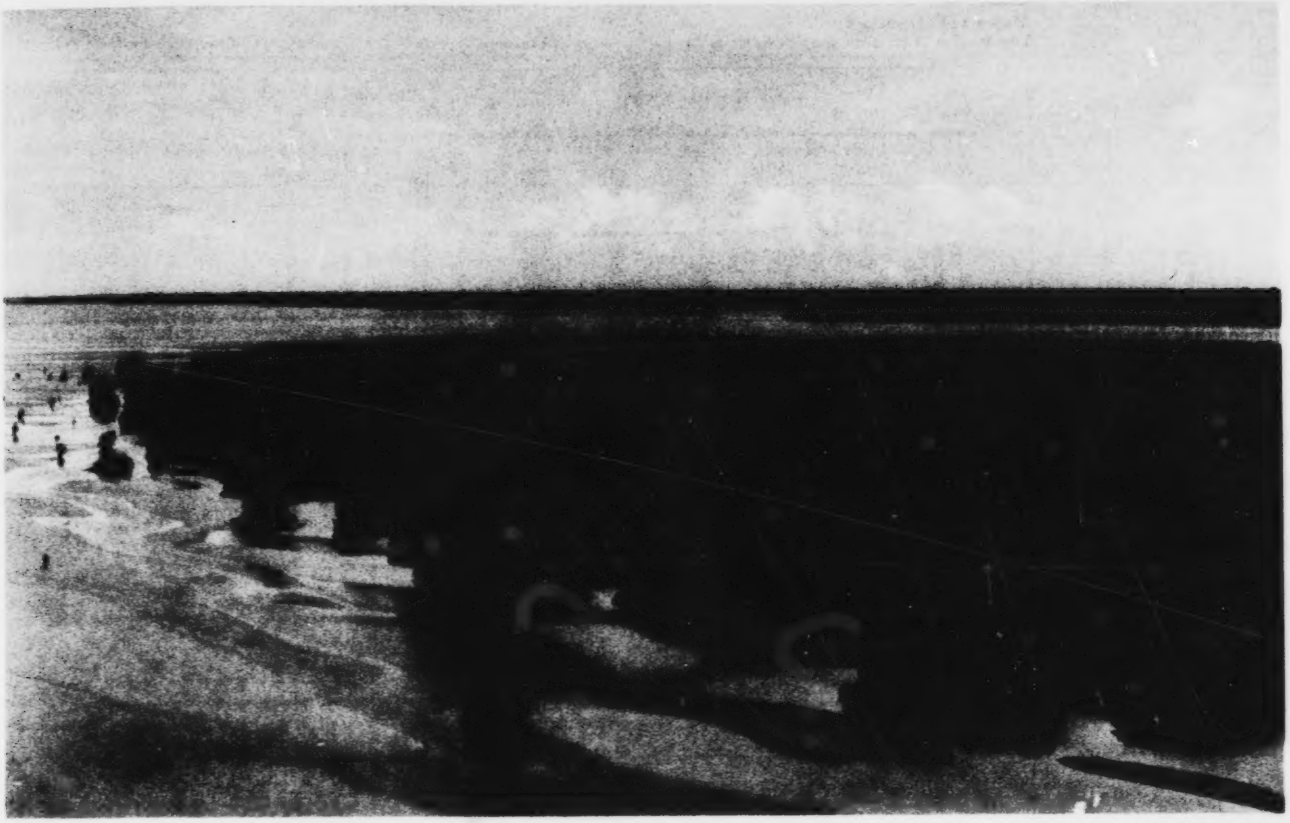
sediment arriving at the coast is deflected northwestwards by the prevailing currents and longshore drift and is deposited in a narrow belt along the innermost shore, either on the coast or in the Gulf of Paria; an estimated 30% is carried farther north and west past Trinidad. A large amount of sediment is transported to the Orinoco from farther east, much of it probably originating from the Amazon (e.g., Reyne 1961; NEDECO 1962; van Andel 1967; Gibbs 1970); deposited sediment thus includes material from a wide source area (Imbrie and van Andel 1964; van Andel 1967).

Water discharged from the Orinoco system is enough to reduce the salinity of coastal waters over an extensive area. In the rainy season, the whole ocean surface around Trinidad is covered with brackish water (van Andel and Postma 1954), and normal salinities in April fall to very low values in August. In the rainy season, the western half of the Gulf of Paria is subjected to an estuarine water circulation with brackish water flowing seaward (northwards) out of the gulf through the Dragon's Mouths in the upper layer and a compensating saltwater current flowing southwards into the gulf in the lower layers. With the northwesterly currents, suspended matter tends to be highest in the western part of the Gulf of Paria, and bottom sediments here show higher levels of organic matter, which lead to reduced pH values of the sediment as a result of the decay of the organic matter (van Andel and Postma 1954).

Four main types of coastline may be distinguished within the delta: (1) the steep rocky coast of the Paria Peninsula (Venezuela) and Northern Range Mountains (Trinidad); (2) the cliff and beach coast of southern and southwestern Trinidad; (3) the prograding coasts of the Orinoco and Caroni deltas, where sediment is supplied from the land; and (4) the muddy shores of the western gulf, where sediments are brought from the sea.

The outer delta is subject to extensive tidal flooding. Interior areas of the delta are covered with swamp vegetation; mangroves develop along saline and brackish areas on the outer coast and rivers and forest along the stream margins farther inland (Muller 1959). Where sandy chenier-type ridges develop, shrubby dune vegetation occurs. The outer belt of mangrove forest consists mostly of *Rhizophora mangle*, together with *Avicennia nitida*, and penetrates some distance inland along the estuaries. *Avicennia* is almost absent in the strongly dissected southeastern delta area, but is much more abundant along the straight central and northern parts. It does not usually occur in the outermost belt of vegetation, generally occupying the inner parts of the mangrove forest. *Laguncularia racemosa* occurs only locally. Soils are generally soft bluish-grey clay.

A mixed swamp forest often develops immediately behind the mangrove belt, especially in the southeastern part of the delta, where tidal influence is restricted. A small number of dominant trees occurs, including *Symphonia*



Orinoco River delta, Venezuela. The southern part of the Orinoco delta supports large numbers of Nearctic shorebirds, especially where mudflats have built up in front of the mangrove-lined shores near river channel exits.

globulifera, *Pterocarpus officinalis*, *Bombax aquaticum*, and the palms *Euterpe* spp. and *Manicaria sacchifera*. Soils are very soft humic clays with abundant decaying plant material.

Over 84 100 Nearctic shorebirds were counted on the Venezuelan coast of the Orinoco delta between the Paria Peninsula and the border with Guyana (Sectors 58–77; Table 6.9), representing 64.8% of the overall Venezuelan total. The area was especially important for small shorebirds, holding 69 600 (73.7% of the Venezuelan total of 94 500); this total was regionally significant, representing 3.3% of the North Coast total (Table 6.1) and being the largest eco-unit total on the north coast outside the Guianas and north-central Brazil. Regionally significant numbers of Sanderling were also found in the area, the total of 460 being 10.5% of the North Coast total (4400) and 70.3% of the total for Venezuela (650). The totals for medium-sized (14 000) and large (480) species also represented substantial proportions (43.2 and 34.2%) of the respective Venezuelan totals; the 3100 dowitchers comprised 6.5% of the North Coast total for that species.

Concentrations of shorebirds appeared to be highly localized within the delta area. The majority—75 200 (89.4%) of the overall total of 84 100—occurred in the southern part of the delta on shorelines facing the Atlantic (Sectors 68–77), with only a minority (9000 or 10.6%) being found on the shores of the Gulf of Paria (Sectors 58–67) (Table 6.11). The major exception was the Sanderling, which was identified only on the sandy beaches along the south coast of the Paria Peninsula in Sector 58. The largest concentrations of small species on the Venezuelan coast in the Gulf of Paria were also on the south side of the Paria Peninsula in Sector 59 closer to the mouth of the Cano Ajies, where mangroves and muddy patches lined the shore (Table 6.10). The tide was generally very high during the surveys, with the water right in to the fringing mangrove forest, so that few roosting areas were available for shorebirds. Substrates were generally sandy. Small numbers of Ruddy Turnstones and Black-bellied Plovers were found along stretches where tough mudbanks occurred in front of an open grassy type of savannah hinterland, as in Sector 66.

By far the largest concentrations of shorebirds were found near the north end of the Isla de Mariusa (Sector 69), where the total of 51 300 included 37 900 small shorebirds (small *Calidris* spp.) and 13 300 medium-sized species, including significant numbers (3100) of dowitchers (Table 6.9). The birds occurred in an area where muddy channels and flats were exposed in front of extensive growths of new, emergent mangroves. The smaller numbers of shorebirds (1400) in Sector 71 were found in similar habitats, with muddy channels and new emergent mangrove growth near Punta Araguabisi on the southeast side of a river channel exit. A second major concentration of small shorebirds occurred on the flats just to the north of the main channel—the Boca Grande—of the Orinoco River (Sector 75), where 20 300 peeps were recorded. Moderate concentrations of small and medium-sized species occurred on the mudflats east of the Boca Grande on the coastline towards the border with Guiana. The 800 small shorebirds in Sector 76 were found roosting on the roof of a hut on stilts in the river near San Jose de Amacuro.

Map 6.4 (Venezuela-4)
Distribution of Nearctic shorebirds along the eastern coast of Venezuela

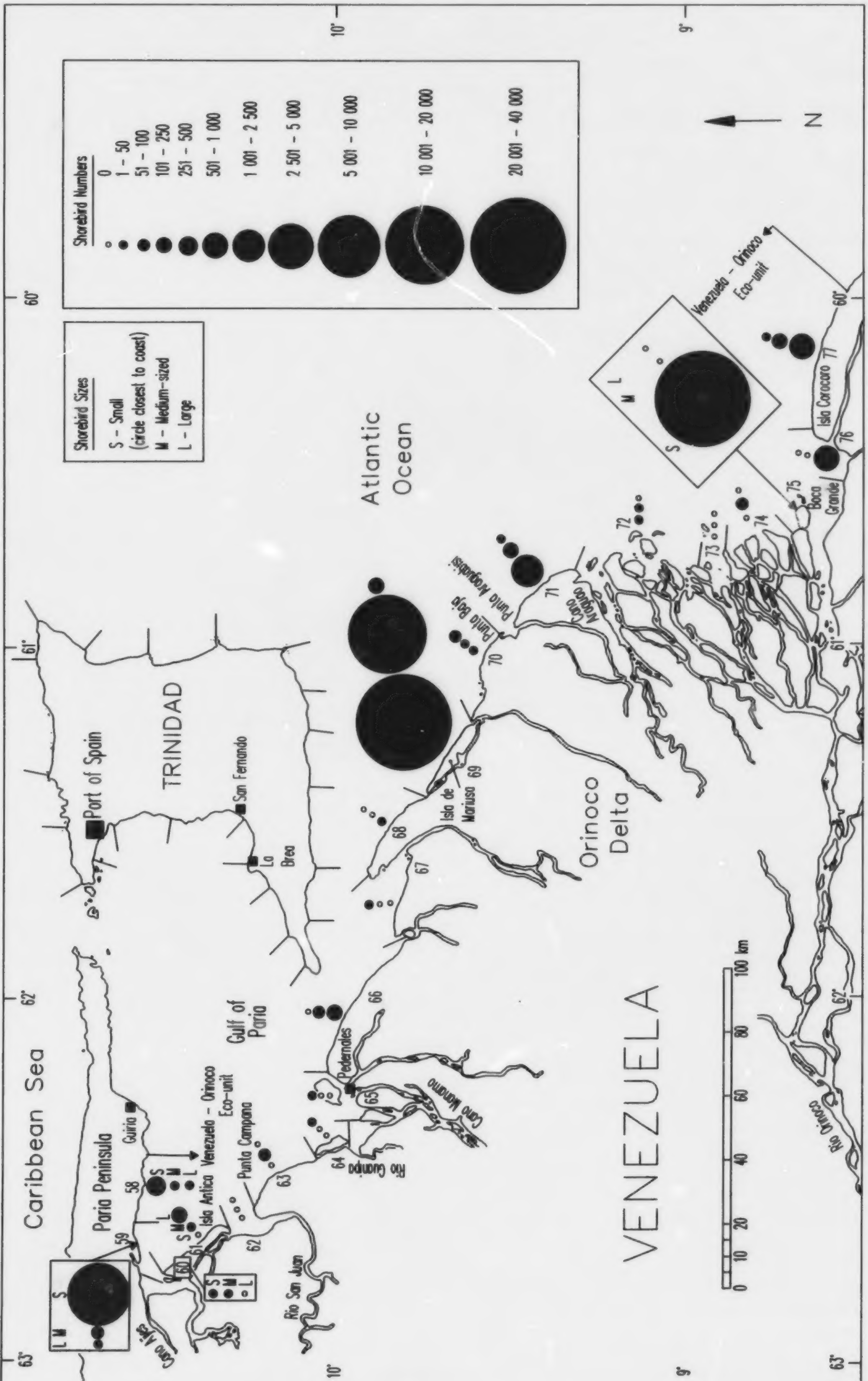

Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
N
Caribbean Sea
Paria Peninsula
Güiria
TRINIDAD
Port of Spain
San Fernando
La Brea
Gulf of Paria
Atlantic Ocean
Orinoco Delta
VENEZUELA
Venezuela - Orinoco Eco-unit
Isla Antica
Punta Campana
Pedernales
Isla de Mariusa
Punta Bajo
Punta Araguapiche
Caño Araguao
Boca Grande
Isla Corocoro
Caño Ajies
Río San Juan
Río Guanipa
Caño Manamo
Río Orinoco
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
S
M
L
0
10
20
40
60
80
100 km
10°
9°
60°
61°
62°
63°

Table 6.9
Totals of Nearctic shorebirds in survey sectors in Map 6.4 (Venezuela-4)

Sector no.	Sector length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
58	16.5	0	460	0	460	0	0	0	0	40	40	0	50	50	550
59	20.0	0	0	7 801	7 801	0	0	15	0	45	60	12	8	20	7 881
60	0.0	0	0	3	3	0	0	1	0	5	6	0	0	0	9
61	28.9	0	0	0	0	0	0	0	0	15	15	43	85	128	143
62	35.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	31.6	0	0	0	0	70	0	0	0	0	70	0	0	0	70
64	9.9	0	0	0	0	0	0	0	0	0	0	35	0	35	35
65	19.9	0	0	0	0	0	0	0	0	0	0	7	18	25	25
66	51.6	2	0	186	188	36	21	0	0	0	57	0	0	0	245
67	41.3	0	0	0	0	0	0	0	0	0	0	2	0	2	2
68	34.2	0	0	4	4	0	0	0	0	0	0	0	0	0	4
69	27.7	0	0	37 870	37 870	9	13	152	3 100	10 010	13 284	33	112	145	51 299
70	35.5	3	0	0	3	8	0	0	0	0	8	71	0	71	82
71	30.7	0	0	1 202	1 202	14	8	0	0	200	222	2	0	2	1 426
72	36.9	1	0	0	1	3	0	20	0	0	23	0	0	0	24
73	16.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	27.9	0	0	0	0	0	0	55	0	0	55	0	0	0	55
75	21.1	0	0	20 300	20 300	0	0	0	0	0	0	0	0	0	20 300
76	22.5	1	0	800	801	0	0	0	0	0	0	0	0	0	801
77	41.2	0	0	1 000	1 000	3	0	65	0	120	188	2	0	2	1 190
Total	549.2	7	460	69 166	69 633	143	42	308	3 100	10 435	14 028	207	273	480	84 141

Table 6.10
Principal habitats in survey sectors in Map 6.4 (Venezuela-4)

Sector no.	Habitat description
58	Narrow beach, mud- and sandflats, some mangroves / forest, palms / open forest, grassland
59	Muddy beach, mangroves / forest
60	Inland; stagnant swamp / forest
61	Narrow sand beach, mangroves / forest, swamp
62	Mudbanks along brackish estuary / forest
63	Broad sand beach with some mudflats, mangroves / forest
64	Sand and mud beach, mangroves / forest
65	Broad sand- and mudflats, mangroves / forest
66	Broad sand beach and mudflats, mangroves / forest, marshes, lagoons
67	Mangroves with tough muddy beaches / forest
68	Mangroves with some mudflats / forest
69	Broad mudflats and sand beach, mangroves / forest
70	Broad sand beaches and bars / scrubby forest, grassland
71	Sand beach with some broad mudflats, mangroves / forest
72	Sand beach, mangroves / forest
73	Sand beach, some mudflats, mangroves / palm scrub, forest
74	Sand beach, some mudflats, mangroves / palm scrub, forest
75	Major river channel with sandbars, some mudflats, mangroves / forest, river tributaries
76	Soft mudbanks, mangroves and palms / forest
77	Broad mudflats, mangroves and palms / forest

Table 6.11
Subtotals of Nearctic shorebirds in the Gulf of Paria and Atlantic sections of the Venezuelan coast of the Orinoco delta

Area	Total sector length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Gulf of Paria (Sectors 58–67)	255.2	8 452 (12.1%)	248 (1.8%)	260 (54.2%)	8 960 (10.6%)
Atlantic coast (Sectors 68–77)	294.0	61 181 (87.9%)	13 780 (98.2%)	220 (45.8%)	75 181 (89.4%)
Total	549.2	69 633	14 028	480	84 141

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Chapter 7

Trinidad

R.I.G. Morrison, R.K. Ross, and B. Ramdial

7.1. General geography

Trinidad lies approximately between 10 and 11°N and between 61 and 62°W, off the Orinoco River delta region of northeastern Venezuela. It is roughly rectangular in shape, averaging about 80 km in length and 60 km in width, with peninsulas in the northwest and southwest, which come to within about 18 km of the coast of Venezuela. The surface area is 4769 km^2 (Ramdial 1980). Geographically and biologically, Trinidad may be considered part of the South American continent, rather than as an extension of the West Indian islands.

Trinidad can be divided into five major regions, which consist of three ranges of mountains/hills and the intervening lowlands (e.g., Barr and Saunders 1970; Ramdial 1980) (Fig. 7.1):

(1) The *Northern Range*, which runs along the north coast of the island, is an extension of the Cordillera de la Costa Oriental of northeastern Venezuela and represents the most easterly extension of the Andes in South America. The deeply dissected mountains reach a maximum elevation of 940 m and result in a steep northern coastline.

(2) The *Caroni Plains* lie south of the Northern Range and consist of low-lying areas of terraces, alluvial plains, and swamp deposits. The Caroni River drains the area to the west and the Oropuche River to the east.

(3) The *Central Range* consists of a low line of hills running diagonally northeast-southwestwards across the island from Manzanilla in the east to Pointe-a-Pierre in the west. Elevations range between 60 and 150 m, with the highest peak being Mount Tamana at 308 m.

(4) The *Southern Lowlands* lie south of the Central Range, forming a belt of low, rolling country that may be divided into the Nariva Plain in the east and the Naparima Plain in the west.

(5) The *Southern Range* runs along the south coast of the island, producing a steep, although not very high, shoreline. Elevations are generally less than 150 m, rising to about 250 m at the Moruga Hills around the middle of the coast, with the highest point at the Trinity Hills (304 m) towards its eastern end.

The climate of Trinidad is tropical, with average annual day and night temperatures of 29 and 23°C, respectively (Ramdial 1980). Annual average rainfall ranges from 170 cm in the north/northeast to 334 cm in the south/southwest: there are distinct dry (January–May) and wet (June–December) seasons, with a short dry period in September/October. The prevailing trade winds are from the east/northeast.

7.2. Trinidad eco-unit

Sectors 1–28; Map 7.1 (Trinidad)

More than 13 600 Nearctic shorebirds were found in Trinidad in February 1982, made up mostly of small species (12 400, 90.9%), with smaller numbers of medium-sized (990, 7.2%) and large (260, 1.9%) species (Table 7.1). The majority of the small species were *Calidris* sandpipers (Table 7.2*a*), principally the Semipalmated Sandpiper *C. pusilla* and Western Sandpiper *C. mauri*, both of which are common in Trinidad, occurring together on the mudflats (ffrench 1976). Other species found in moderate numbers included Black-bellied Plovers *Pluvialis squatarola* (170), yellowlegs *Tringa* spp. (520), dowitchers *Limnodromus* spp. (210), Whimbrels *Numenius phaeopus* (75), and Willets *Catoptrophorus semipalmatus* (180) (Table 7.2*b*, 7.2*c*). Spotted Sandpipers *Actitis macularia* are also found in moderate numbers, especially on the west coast (C. James, pers. commun.).

All but 38 (22 small, 16 medium-sized) of the shorebirds observed in Trinidad were found on the west coast in Sectors 1–12 (Table 7.3, Map 7.1 [Trinidad]), bordering the Gulf of Paria. Although the species and category totals were not very high in relation to the relevant totals for the north coast of South America or for the continent (Table 7.2*a–c*), the west coast habitats are certainly of local importance and undoubtedly hold many more birds during migration periods. More shorebirds were found on the west coast of Trinidad than on the Venezuelan coastlines of the Gulf of Paria, the sectors in Trinidad accounting for 13 600 (60.3%) of the total of some 22 600 shorebirds found in this area, with totals for both small (peeps) and medium-sized species exceeding those found in Venezuela (Table 7.4).

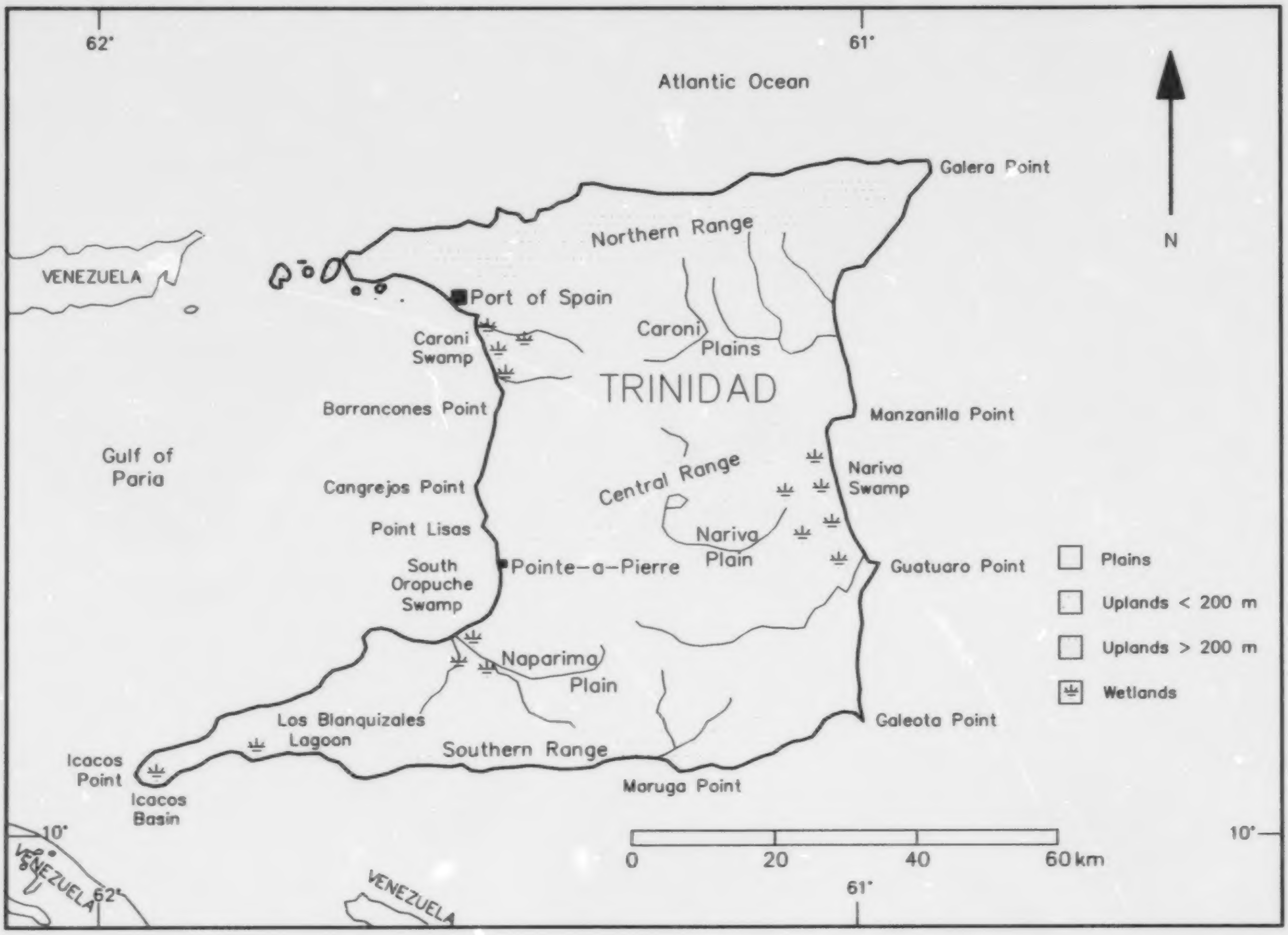
7.2.1. West coast

Sectors 1–12; Map 7.1 (Trinidad)

Port-of-Spain, the capital of Trinidad, lies in Sector 1: much of the shoreline that does not consist of urban development is gravel or rocky, and little shorebird habitat is present.

Sector 2 comprises the Caroni Swamp (Table 7.6); this area is one of the most important wetlands in Trinidad, although it is now threatened by a number of factors, including pollution, reclamation, industrial development, hunting, and tourism. The swamp is bounded approximately by the Caroni and Madame Espagnol rivers to the north and south, respectively, and the Princess

Figure 7.1
Some of the main geographical features of Trinidad


62°
61°
Atlantic Ocean
N
Galera Point
Northern Range
VENEZUELA
Port of Spain
Caroni Swamp
Caroni Plains
TRINIDAD
Barrancones Point
Manzanilla Point
Gulf of Paria
Central Range
Nariva Swamp
Cangrejos Point
Point Lisas
Nariva Plain
South Oropuche Swamp
Pointe-a-Pierre
Guatuaro Point
Plains
Uplands < 200 m
Uplands > 200 m
Wetlands
Naparima Plain
Los Blanquizales Lagoon
Galeota Point
Southern Range
Icacos Point
Icacos Basin
Moruga Point
10°
0
20
40
60 km
VENEZUELA
VENEZUELA
62°
61°
10°

Margaret Highway to the east, and it is crossed by the Blue and Guayamare rivers. It consists of 5611 ha of coastal mangrove forest, brackish and saline lagoons, extensive mangrove swamps, brackish marshes, and grasslands. The mangroves consist principally of *Rhizophora mangle*, followed by *Avicennia germinans* and *Laguncularia racemosa*, and cover over 3500 ha (Scott and Carbonell 1986).

Moderate numbers of shorebirds were found in the swamp itself, mostly in areas of open mangrove with shallow ponds having wide muddy margins and in the sewage lagoons towards the north end. Medium-sized species were most common (660), including yellowlegs (430), dowitchers (180), and Black-bellied Plovers (44), followed by peeps (420) (Table 7.5).

The Caroni Rice Project, located inland to the east of the Caroni Swamp, functions as an important feeding area for a variety of shorebirds, including Western Sandpipers, Semipalmated Sandpipers, yellowlegs, Willets, Whimbrels, and dowitchers; numbers vary seasonally and may be classified as moderate (C. James, pers. commun.).

The outer coast of the Caroni Swamp appeared to have rather narrow flats, which were completely covered at high tide, and few shorebirds were found there (Sector 3). The most important mud- and sandflats were found south of the Caroni Swamp in Sectors 4–7. Sections of mudflats and/or sandflats backed by mangrove stands alternated with low clifflets and plantations or hilly sections of coast. The most important sections of mudflats/mangroves were found around Barrancones Point, around the mouth of the Couva River at Cangrejos Point, around Point Lisas, and around Pointe-a-Pierre towards the mouth of the Guaracara River. Large flocks of peeps were found on exposed flats in these areas, as well as smaller numbers of medium-sized and large species, the 8600 shorebirds in Sector 6 accounting for 63.2% of the total for Trinidad.

The South Oropuche Swamp (Sector 8) forms another extensive area (5642 ha) of mangrove swamps and lagoons behind a sandbar, along which runs a road. The area appeared to be very heavily polluted with oil, and very few shorebirds or other birds were observed.

Much of the coast between the South Oropuche Swamp and Icacos Point (Sectors 9–12) consists of sandy beaches with rocky points, backed by low forested hills, cliffs, or habitations; few intertidal flats occurred, and few shorebirds were seen. This section of coast was heavily polluted with oil.

7.2.2. South coast

Sectors 13–18; Map 7.1 (Trinidad)

The south coast of Trinidad (Sectors 13–18) consisted mostly of sand beaches backed by forested hills

Table 7.1
Summary totals of Nearctic shorebirds in Trinidad

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Trinidad	483.8				
No. of birds		12 393	986	259	13 638
% of size-class total (North Coast)		0.59	0.29	0.43	0.55
% of grand total (North Coast)		0.50	0.04	0.01	0.55
% of size-class total (South America)		0.53	0.22	0.21	0.47
% of grand total (South America)		0.42	0.03	0.01	0.47

Table 7.2*a*
Totals of Nearctic shorebird species in Trinidad—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Trinidad	483.8				
No. of birds		21	5	12 367	12 393
% of species total (North Coast)		5.83	0.11	0.59	0.59
% of size-class total (North Coast)		0.00	0.00	0.59	0.59
% of grand total (North Coast)		0.00	0.00	0.50	0.50
% of species total (South America)		4.87	0.00	0.56	0.53
% of size-class total (South America)		0.00	0.00	0.53	0.53
% of grand total (South America)		0.00	0.00	0.42	0.42

Table 7.2*b*
Totals of Nearctic shorebird species in Trinidad—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Trinidad	483.8						
No. of birds		173	6	518	209	80	986
% of species total (North Coast)		0.73	0.03	0.63	0.44	0.05	0.29
% of size-class total (North Coast)		0.05	0.00	0.15	0.06	0.02	0.29
% of grand total (North Coast)		0.01	0.00	0.02	0.01	0.00	0.04
% of species total (South America)		0.63	0.03	0.57	0.43	0.04	0.22
% of size-class total (South America)		0.04	0.00	0.11	0.05	0.02	0.22
% of grand total (South America)		0.01	0.00	0.02	0.01	0.00	0.03

Table 7.2*c*
Totals of Nearctic shorebird species in Trinidad—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Total large shorebirds
Trinidad	483.8			
No. of birds		75	184	259
% of species total (North Coast)		0.49	0.46	0.43
% of size-class total (North Coast)		0.12	0.30	0.43
% of grand total (North Coast)		0.00	0.01	0.01
% of species total (South America)		0.30	0.41	0.21
% of size-class total (South America)		0.06	0.15	0.21
% of grand total (South America)		0.00	0.01	0.01

(Table 7.6). Some wetlands occurred near the western end, including Icacos Basin (Sector 13) and the Los Blanquizales Lagoon (Sector 14) (Fig. 7.1). Very few shorebirds (27) were seen along this coast (Table 7.5).

7.2.3. East coast

Sectors 19–22, 28; Map 7.1 (Trinidad)

The east coast of Trinidad (Sectors 19–22) consisted of long sweeps of beach interrupted by rocky points (Table 7.6). Oil pollution was noted along much of the coast, being especially heavy in the northern half in Sectors 21 and 22. Few shorebirds (10) were seen (Table 7.5), either on the coast or in the extensive brackish and freshwater Nariva Swamp (Sector 28), which contained much deep water and was heavily overgrown with vegetation. Some shorebirds are observed seasonally (February/March) on the coast in Sector 21, including Black-bellied Plovers, Ruddy Turnstones *Arenaria interpres*, dowitchers, and peeps (C. James, pers. commun.).

7.2.4. North coast

Sectors 23–27; Map 7.1 (Trinidad)

The north coast (Sectors 23–27) was generally very steep, with little shorebird habitat (Table 7.6). The area was practically devoid of Nearctic shorebirds (Table 7.5).

Table 7.3
Distribution of Nearctic shorebirds around the coast of Trinidad

Location	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
West coast	12 371	970	259	13 600
Other coasts	22	16	0	38
Total	12 393	986	259	13 638

Table 7.4
Totals of Nearctic shorebirds on the shorelines of the Gulf of Paria in Trinidad and Venezuela

Location	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
W. coast Trinidad (Sectors 1–12)	12 371 (59.4%)	970 (79.6%)	259 (49.9%)	13 600 (60.3%)
Venezuelan coast (Sectors 58–67, Map 6.4)	8 452 (40.6%)	248 (20.4%)	260 (50.1%)	8 960 (39.7%)
Total	20 823	1 218	519	22 560

Map 7.1 (Trinidad)
Distribution of Nearctic shorebirds on the coast of Trinidad

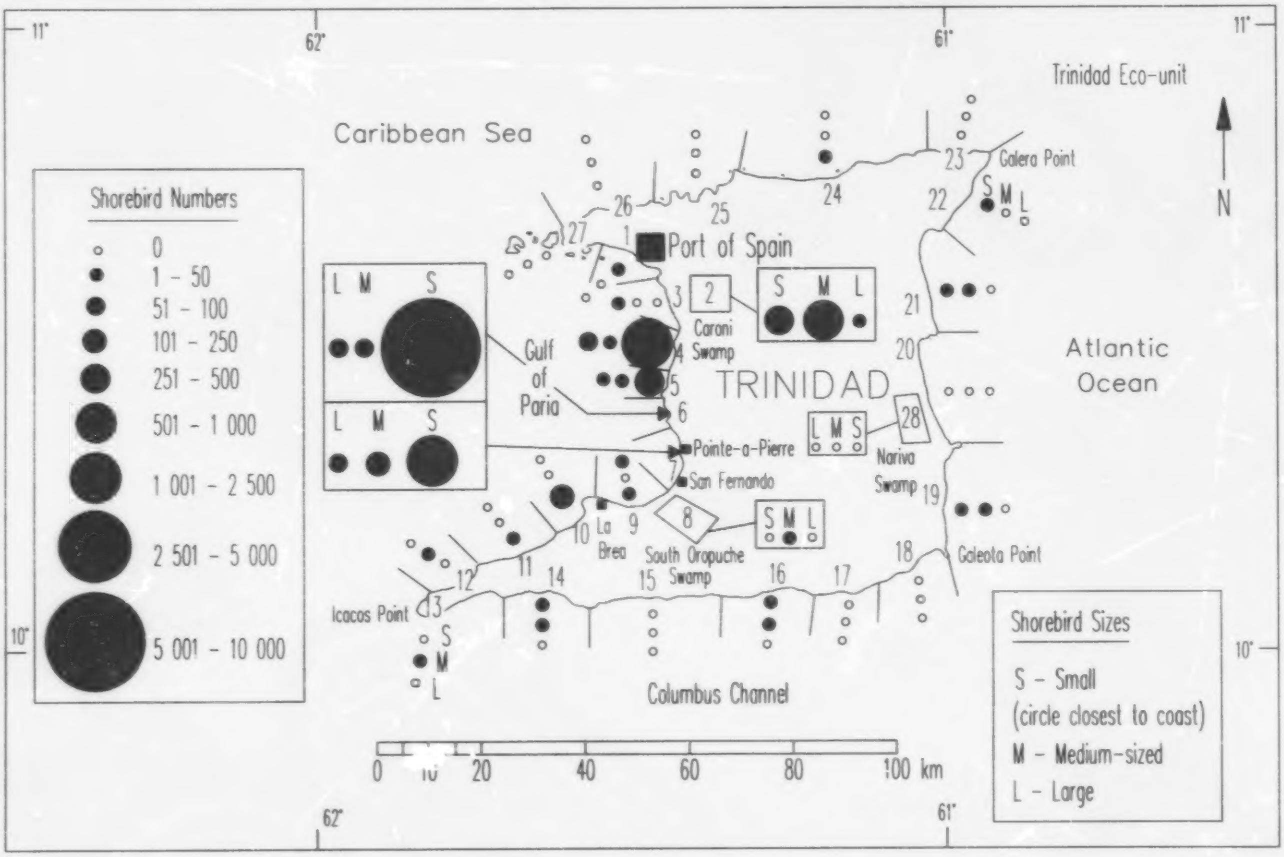

11°
62°
61°
11°
Trinidad Eco-unit
N
Caribbean Sea
Atlantic Ocean
Columbus Channel
Gulf of Paria
TRINIDAD
Port of Spain
Caroni Swamp
Pointe-a-Pierre
San Fernando
La Brea
South Oropuche Swamp
Nariva Swamp
Galera Point
Galeota Point
Icacos Point
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
S M L
L M S
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
0
10
20
40
60
80
100 km
10°
10°

Table 7.5
Totals of Nearctic shorebirds in survey sectors in Map 7.1 (Trinidad)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Dowit-cher species	Uniden-tified medium-sized shorebird species	Total medium-sized shore-birds	Whim-brel	Willet	Total large shore-birds	Total shore-birds
1	17.5	1	0	0	1	0	0	0	0	0	0	0	0	0	1
2	0.0	6	0	422	428	44	0	433	179	0	656	0	1	1	1 085
3	11.1	0	0	0	0	0	0	0	0	0	0	0	20	20	20
4	9.2	1	0	1 200	1 201	1	0	29	0	0	30	34	23	57	1 288
5	9.1	1	0	305	306	5	0	3	0	0	8	27	1	28	342
6	9.6	0	0	8 450	8 450	10	0	51	30	0	91	4	68	72	8 613
7	10.8	1	0	1 830	1 831	101	0	0	0	80	181	10	70	80	2 092
8	0.0	0	0	0	0	0	0	1	0	0	1	0	0	0	1
9	15.0	1	0	30	31	0	0	0	0	0	0	0	1	1	32
10	12.8	0	0	120	120	0	0	0	0	0	0	0	0	0	120
11	17.3	3	0	0	3	0	0	0	0	0	0	0	0	0	3
12	12.1	0	0	0	0	3	0	0	0	0	3	0	0	0	3
13	15.5	0	0	0	0	6	0	0	0	0	6	0	0	0	6
14	23.5	0	0	10	10	2	5	0	0	0	7	0	0	0	17
15	18.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	24.4	3	0	0	3	1	0	0	0	0	1	0	0	0	4
17	24.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	24.5	1	5	0	6	0	1	0	0	0	1	0	0	0	7
20	27.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	23.5	1	0	0	1	0	0	1	0	0	1	0	0	0	2
22	20.1	1	0	0	1	0	0	0	0	0	0	0	0	0	1
23	27.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	26.6	1	0	0	1	0	0	0	0	0	0	0	0	0	1
25	30.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	20.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	40.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	483.8	21	5	12 367	12 393	173	6	518	209	80	986	75	184	259	13 638

Table 7.6
Principal habitats in survey sectors in Map 7.1 (Trinidad)

Sector no.	Habitat description
1	Gravel shore / city
2	Inland; brackish mangrove swamp / scrub / sugarcane fields, habitations
3	Broad mudflats, mangroves / sugarcane fields, marsh
4	Broad mudflats, mangroves / sugarcane fields
5	Narrow sandflats, mangroves around rivers / cliffs / sugarcane fields
6	Small sand- and mudflats with mangroves / seawall in places / industrial development, plantations
7	Gravel beach with some mangroves and mudflats / seawall / industrial development
8	Inland; brackish mangrove swamp with mudflats / forest, plantations
9	Narrow sand beach, rocky points / palms, forested hills, habitations
10	Narrow sand beach / seawall, earth cliffs / industrial development, plantations
11	Narrow sand beach / cliffs / forest, grassland
12	Narrow sand beach / palms, forest, habitations
13	Narrow sand beach / palms, forest, wetlands
14	Narrow sand beach / some cliffs / scrub, forest
15	Narrow sand beach / some cliffs / steep forested hills
16	Narrow sand beach / some cliffs / steep forested hills
17	Narrow sand beach / some cliffs / steep forested hills
18	Narrow sand beach / palms, habitations, forest
19	Narrow sand beach / palm plantations, forest
20	Narrow sand beach / palm plantations, wetlands
21	Narrow sand beach / some low cliffs / forest, farmland, scrub
22	Steep rocky points, some narrow sand beaches / cliffs / forest
23	Steep rocky coast / steep forested hills
24	Steep rocky headlands, some small sand beaches / steep forested hills
25	Steep rocky headlands, some small sand beaches / steep forested hills
26	Steep rocky shore / forested hills
27	Steep rocky shore including islands / large hills with forest and scrub
28	Inland; freshwater marsh, ponds / forest, farmland

7.3. Literature cited

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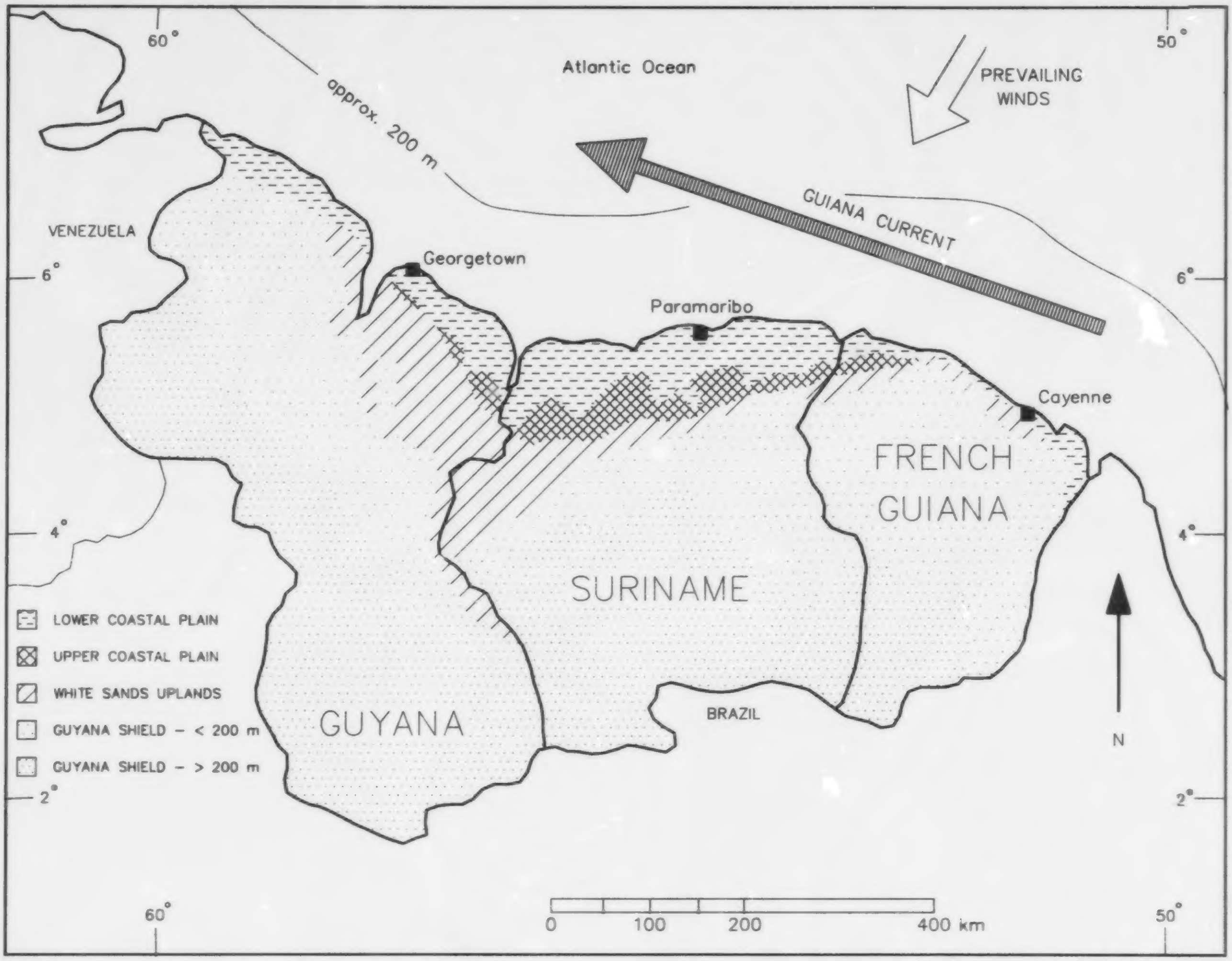
ffrench, R. 1976. A guide to the birds of Trinidad and Tobago. Revised edition. Asa Wright Nature Centre Publ. No. 1. Harrowood Books, Valley Forge, Pa. 470 pp.

Ramdial, B.S. 1980. Forestry in Trinidad and Tobago. For. Div., Min. Agric. Land Fish., Trinidad and Tobago. 27 pp.

Scott, D.A.; Carbonell, M. 1986. A directory of neotropical wetlands. IUCN Cambridge and IWRB Slimbridge. 684 pp.

Figure 8.1
Some of the main geographical features of the Guianas


60°
50°
Atlantic Ocean
PREVAILING
WINDS
approx. 200 m
GUIANA CURRENT
VENEZUELA
6°
Georgetown
Paramaribo
Cayenne
FRENCH
GUIANA
SURINAME
GUYANA
BRAZIL
4°
2°
N
LOWER COASTAL PLAIN
UPPER COASTAL PLAIN
WHITE SANDS UPLANDS
GUYANA SHIELD – < 200 m
GUYANA SHIELD – > 200 m
0
100
200
400 km

Chapter 8

The Guianas

R.I.G. Morrison, R.K. Ross, and B. de Jong

8.1. General geography

The area referred to as the Guianas comprises the three countries of Guyana, Suriname, and French Guiana, lying on the central part of the north coast of South America, approximately between 1 and 9°N and between 51 and 60°W (Fig. 8.1). Suriname, the central of the three countries, in particular, and French Guiana, to the east, contain some of the most important habitat for shorebirds in South America.

The coastline of the Guianas is low and flat, consisting of mudflats, sand ridges, brackish and freshwater swamps, coastal marshes, and extensive mangrove forests. The shoreline forms the seaward edge of a large wedge-shaped plain, which in effect occupies a notch or embayment in the underlying rocks of the Guyana Shield, one of the main morphostructural units of the South American continent. This embayment has been gradually filled up with sediments and can now be regarded as being in a state of labile equilibrium, the coastline undergoing alternate cycles of erosion and accretion (Spirlet 1923; Reyne 1961).

The Guianas may be divided into four distinct physiographic units (Vann 1959*a*, 1959*b*) (Fig. 8.1):

(1) The *Lower Coastal Plain* (Demerara Formation) is of Holocene (Recent) age and includes fluvial and estuarine clays dating from about 10 000 years BP or less. The landscape consists of vast mudflats, mangroves, and sand and shell ridges along the coast, backed by shallow brackish and saline lagoons and swamps, with freshwater marshes and swamp forest, as well as mixed forests on drier sandy ridges inland.

(2) The *Higher Coastal Plain* (Coropina Formation) consists of much dissected clays deposited at or near sea level and since elevated to their present position. Grassy swamps, swamp and dryland forest, and peat swamps are found in this zone.

(3) The *White Sands Uplands*, some 30–60 m in elevation, consist of coarse sands and loams and are characterized by white sand savannahs.

(4) The *Guyana Shield*, where the crystalline basement rocks reach the surface, consists of humid tropical forest, savannahs, rocky outcrops, and a variety of other forest types (Vann 1959*a*, 1959*b*; de Jong *et al.* 1986).

The mudflats of the Guianas are made up principally of sediments discharged from the Amazon River, with local rivers contributing rather little material, as has been demonstrated by analysis of clay mineral composition of the sediments (Lyell 1832; Reyne 1961; de Groot 1966; Allersma 1969; Eisma and van der Marel 1971).

Mud discharged from the Amazon River is transported northwestwards by the North Equatorial (Guiana) Current, and the prevailing trade winds across most of the area result in a steady longshore current flowing in the same direction. Waves produced by this current, along with high tides in the region of the mouth of the Amazon River (up to 10 m), produce a high-energy environment suitable for sediment transport (Gibbs 1970*a*, 1970*b*).

On the Guyanese coast, there is a belt of mud some 20–40 km wide that moves northwestwards at a rate of 20–50 $\mathrm{cm \cdot s^{-1}}$ (NEDECO 1962; Allersma 1969); this belt extends from the mouth of the Amazon River itself as far as the mouth of the Orinoco River. The yearly westward transport of mud off Suriname and Guyana has been estimated as $1\text{–}2 \times 10^8$ $\mathrm{tons \cdot yr^{-1}}$, or about 20–40% of the total yearly estimated sediment load of the Amazon of about 5×10^8 $\mathrm{tons \cdot yr^{-1}}$. Eisma and van der Marel (1971) estimated that the total sediment load of the Guyanese rivers was about 1×10^7 $\mathrm{tons \cdot yr^{-1}}$, about 2% of the total yearly load of the Amazon and 5–10% of the total amount of mud moved westwards along the Guyana coast each year.

The intertidal mudbanks themselves are very mobile and have been estimated to migrate westwards at a rate of about 1–1.5 $\mathrm{km \cdot yr^{-1}}$ (Eisma and van der Marel 1971; Augustinus 1978). This results in a cyclical pattern of erosion and accretion along the coast, occurring over a period of about 30 years (Diephuis 1966). Changes in the coastline may be rapid: at the mouth of the Suriname River, for instance, the coast receded 125–170 $\mathrm{m \cdot yr^{-1}}$ from 1914 to 1919 and about 25 $\mathrm{m \cdot yr^{-1}}$ from 1919 to 1938, whereas from 1938 to 1948 there was an accretion of 60–80 $\mathrm{m \cdot yr^{-1}}$ at the mouth and 140 $\mathrm{m \cdot yr^{-1}}$ at Cat Creek to the east (Zonneveld 1953, 1954). Similar examples are known for both Guyana and French Guiana (Choubert 1949; Reyne 1961). Equivalent changes in the coastline resulting from fluctuations in sea level over longer periods may be traced through pollen analysis of soil cores from the coastal lowlands (van der Hammen 1963, 1974, 1983; Wijmstra 1971).

Depositional areas on the lower flats often consist of a very unconsolidated soupy, gel-like mud, or "sling-mud." The upper flats in front of the mangroves consist of a band of tougher mud, where less frequent inundation allows some drying, drainage, and consolidation. Relatively low densities of invertebrates occur on the lower flats, probably as a result of the instability of the sediments, with the highest densities occurring around mean high-tide level (Swennen *et al.* 1982). Highest biomass of invertebrates occurs at around high-tide level at the border of the mangrove forest, resulting mainly from the large numbers of crabs (*Uca* spp.); high biomass values (mainly of Tanaidacea) also occur just below this zone. Benthic invertebrates consist principally of crustaceans (tanaid shrimps), with much lower numbers of polychaetes and molluscs, as may be characteristic of muddy intertidal areas in the tropics (Swennen *et al.* 1982).

The coastline of the Guianas is somewhat unusual in that the dominant colonizing plant is the black mangrove *Avicennia germinans*, in contrast to other areas where the red mangrove *Rhizophora mangle* often prevails. *Avicennia* seems particularly well adapted to grow on the heavily oxidized clay soils through its rapidly developing root system; its ability to adjust to rapid sedimentation may explain its domination along the outer coast of the Guianas (Vann 1959*b*, 1969; Boyé 1962). A further result is that much of the intertidal area consists of bare mudflats, in contrast to regions where red mangroves form the outer fringe of vegetation and may grow as far as mid-tide level (Swennen *et al.* 1982).

Another characteristic habitat of the Suriname coast is the complex of saline lagoons and salt pans found behind the outer shoreline. These can arise where drainage of seawater flooding the forest during spring tides is impeded, leading to the development of hypersaline conditions through evaporation and subsequent death of the mangroves. The resulting open muddy areas are littered with dead mangrove trunks and may in time develop halophytic vegetation or become true tidal lagoons if drainage is restored.

Coastal muds of Suriname and Guyana are about 1–2% organic carbon, although the concentration varies considerably. Highest values, as well as highest carbon/nitrogen ratios (15–20), occur near shore and in river mouths (NEDECO 1962), indicating that most of the inorganic matter is derived from coastal vegetation.

Sand and shell ridges form another characteristic habitat of the coastal zone. Like the mudflats, they can be very mobile and have been estimated to move westwards at an average rate of 1.7 $\mathrm{km \cdot yr^{-1}}$ in Suriname (Schulz *et al.* 1977). Sand ridges typically occur to the west of major rivers, where discharged sand is redistributed by longshore currents and wave action, being built up into bars at the limit of high water. At present, little sand is thought to reach the coast from local rivers; during the last period of low sea level, however, much sand was transported to the coast (Krook 1971).

Tidal ranges are from 1 to 2.8 m on neap and spring tides, respectively, with an average amplitude of 1.8 m (NEDECO 1962). The climate is humid tropical: the temperature averages 27°C in Paramaribo. Water surface temperatures are about 28°C and reach much higher values in pools on the exposed flats during the day (Swennen *et al.* 1982). Salinities of nearshore waters are reduced by input of fresh water from both the Amazon River and local rivers (Gibbs 1970*b*; Swennen *et al.* 1982). The prevailing trade winds blow from the northeast. Rain falls throughout the year. In Suriname, four seasons occur: a long, rainy season from April to August, followed by a long dry season from September to November, with short rainy and dry seasons from December to January and February to March, respectively.

8.2. Guyana eco-unit

Sectors 1–13; Map 8.1 (Guyana)

Totals of Nearctic shorebirds found in Guyana on the surveys in February 1982 were low (Table 8.1) in comparison with the much larger numbers in neighbouring Suriname (see Section 8.3). The total of 21 800 shorebirds represented less than 1% of the overall North Coast total. Medium-sized species predominated (11 600), making up 53.4% of the total for Guyana. Of these, yellowlegs *Tringa* spp. (6800) and dowitchers *Limnodromus* spp. (2900) occurred in significant numbers, making up 8.3 and 6.1% of the North Coast totals and 7.5 and 5.9% of the overall South American total for the respective species (Table 8.2*b*). Black-bellied Plovers *Pluvialis squatarola* were also moderately numerous (600), with 2.5% of the North Coast total (Table 8.2*b*).

Most of the shoreline of Guyana west of the Essequibo River, towards Waini Point near the border with Venezuela, consists of a narrow coral sand beach, particularly in Sectors 1–4 (Table 8.4). The small numbers of shorebirds seen in Sector 4 were found on an isolated tongue of mudflats being colonized by mangroves (Table 8.3). Little foreshore was observed during the high-tide surveys in Sectors 5, 6, or 7, which contained tough muddy sections with dying mangroves, beaches, and long sections of sea wall towards the Essequibo River and between the Essequibo and Demerara rivers (Sector 8).

Nearly all the significant shorebird habitat—and shorebirds—occurred in the eastern half of Guyana, between the Demerara River and the Courantyne River on the border with Suriname: 21 000 or 96.4% of the total of 21 800 occurred in this section (Sectors 9–13). Shorebirds were most numerous in Sector 11, which contained extensive mudflats, and less numerous in Sectors 10, 12, and 13, which contained sandier sections. Many of the birds observed in Sectors 12 and 13 occurred on muddy areas at the top of the sandflats.

In addition to the moderate concentrations of wintering birds using the area, large numbers are thought to pass through during migration (Morrison 1984).

8.3. Suriname eco-unit

Sectors 1–14; Map 8.2 (Suriname)

Suriname was by far the most important area in South America for wintering shorebirds in terms of both numbers and general importance to a wide range of species. The overall total of 1 526 000 shorebirds counted on surveys in Suriname in February 1982 represented 61.1% of the total for the North Coast region and 52.3% of the entire South American total (Table 8.5). Small shorebirds made up the bulk (1 347 000 or 88.2%) of the total, followed by medium-sized species (148 000 or 9.7%) and large species (21 500 or 1.4%); a further 10 000 birds (0.7%) were not classified by size.

The totals for each size category represented very significant proportions of the respective continental populations: 57.9% of small shorebirds, 32.4% of medium-sized species, and 17.8% of large species. Proportions of the regional North Coast totals found in Suriname were 64.5, 44.2, and 35.5% for small, medium-sized, and large species, respectively.

Small shorebirds seen on the surveys consisted principally of small *Calidris* sandpipers, mostly Semipalmated

Table 8.1
Summary totals of Nearctic shorebirds in Guyana

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Guyana	478.5				
No. of birds		9 808	11 618	340	21 766
% of size-class total (North Coast)		0.47	3.47	0.56	0.87
% of grand total (North Coast)		0.39	0.47	0.01	0.87
% of size-class total (South America)		0.42	2.54	0.28	0.75
% of grand total (South America)		0.34	0.40	0.01	0.75

Table 8.2*a*
Totals of Nearctic shorebird species in Guyana—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Guyana	478.5				
No. of birds		23	30	9 755	9 808
% of species total (North Coast)		6.39	0.69	0.47	0.47
% of size-class total (North Coast)		0.00	0.00	0.47	0.47
% of grand total (North Coast)		0.00	0.00	0.39	0.39
% of species total (South America)		5.34	0.03	0.44	0.42
% of size-class total (South America)		0.00	0.00	0.42	0.42
% of grand total (South America)		0.00	0.00	0.33	0.34

Table 8.2*b*
Totals of Nearctic shorebird species in Guyana—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Guyana	478.5						
No. of birds		598	48	6 824	2 900	1 248	11 618
% of species total (North Coast)		2.52	0.24	8.25	6.11	0.82	3.47
% of size-class total (North Coast)		0.18	0.01	2.04	0.87	0.37	3.47
% of grand total (North Coast)		0.02	0.00	0.27	0.12	0.05	0.47
% of species total (South America)		2.19	0.20	7.49	5.94	0.67	2.54
% of size-class total (South America)		0.13	0.01	1.49	0.63	0.27	2.54
% of grand total (South America)		0.02	0.00	0.23	0.10	0.04	0.40

Table 8.2*c*
Totals of Nearctic shorebird species in Guyana—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Total large shorebirds
Guyana	478.5			
No. of birds		57	283	340
% of species total (North Coast)		0.37	0.71	0.56
% of size-class total (North Coast)		0.09	0.47	0.56
% of grand total (North Coast)		0.00	0.01	0.01
% of species total (South America)		0.23	0.64	0.28
% of size-class total (South America)		0.05	0.23	0.28
% of grand total (South America)		0.00	0.01	0.01

Sandpipers *C. pusilla* (Table 8.6*a*). The total also included smaller but still significant numbers of Western Sandpipers *C. mauri*, Least Sandpipers *C. minutilla*, and plovers of the genus *Charadrius*, all of which are known to occur in large numbers in Suriname (Spaans 1978, 1979). Peeps were most numerous on the extensive mudflats occurring along the coast of Suriname, especially the Wia-Wia bank in the east of the country, the flats at the mouth of the Coppename River, and the flats in the west of the country towards Nieuw Nickerie (see below).

Suriname is of exceptional importance for yellowlegs and is clearly the centre of distribution for this species on the north coast of South America. The total of 66 400 represented 80.3% of the North Coast total and 72.8% of the population for the continent (Table 8.6*b*). Yellowlegs appeared to be most numerous in the central and western parts of the country (Table 8.7), where they occurred on the top of the extensive mudflats. Ground observations indicated that they are also common in the lagoons behind the outer shoreline.

Suriname was also of considerable importance for dowitchers, the total of 21 800 representing 46.1 and 44.7% of the North Coast and South American totals, respectively (Table 8.6*b*). Most birds identified as

Map 8.1 (Guyana)
Distribution of Nearctic shorebirds on the coast of Guyana

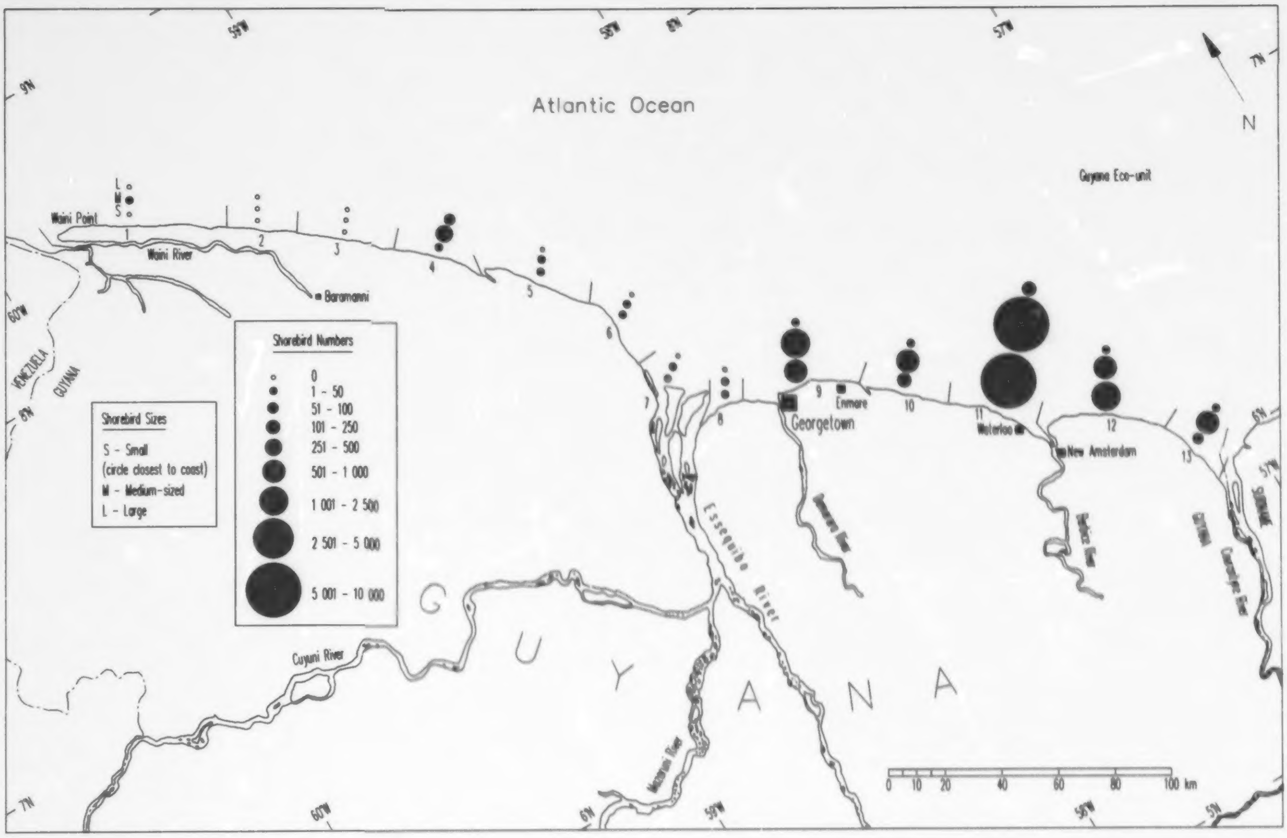

Atlantic Ocean
N
Guyana Eco-unit
L
M
S
Waini Point
Waini River
Baramanni
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
VENEZUELA
GUYANA
Georgetown
Enmore
Waterloo
New Amsterdam
Essequibo River
Demerara River
Berbice River
Cuyuni River
Mazaruni River
Courantyne River
SURINAME
G U Y A N A
1
2
3
4
5
6
7
8
9
10
11
12
13
0 10 20 40 60 80 100 km
59°W
58°W
57°W
60°W
9°N
8°N
7°N
6°N

Table 8.3
Totals of Nearctic shorebirds in survey sectors in Map 8.1 (Guyana)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Dowit-cher species	Uniden-tified medium-sized shorebird species	Total medium-sized shore-birds	Whim-brel	Willet	Total large shore-birds	Total shore-birds
1	83.4	0	0	0	0	0	0	5	0	2	7	0	0	0	7
2	25.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	38.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	25.8	0	0	40	40	44	0	414	0	0	458	1	93	94	592
5	40.7	4	0	0	4	0	0	6	0	0	6	0	0	0	10
6	30.6	1	5	20	26	13	0	7	0	2	22	0	0	0	48
7	35.6	1	2	40	43	0	0	5	0	0	5	0	0	0	48
8	24.4	10	10	15	35	20	0	4	0	12	36	0	0	0	71
9	33.8	0	0	655	655	111	0	1 501	0	415	2 027	0	6	6	2 688
10	32.8	1	0	248	249	0	0	899	0	5	904	1	6	7	1 160
11	34.3	1	0	6 418	6 419	122	2	3 405	2 900	508	6 937	44	126	170	13 526
12	38.8	2	2	2 269	2 273	186	8	478	0	0	672	6	44	50	2 995
13	33.6	3	11	50	64	102	38	100	0	304	544	5	8	13	621
Total	478.5	23	30	9 755	9 808	598	48	6 824	2 900	1 248	11 618	57	283	340	21 766

Table 8.4
Principal habitats in survey sectors in Map 8.1 (Guyana)

Sector no.	Habitat description
1	Narrow sand beach / forest
2	Narrow sand beach, mangroves / forest
3	Sand beach, mangroves / open scrubland
4	Sandy mud shore, mangroves / open scrub, marshland
5	Tough mud shore, mangroves / forest, plantations
6	Narrow sand beach and mudflats / seawall / habitations, plantations
7	Sand beach, tough mudflats, mangroves / scrub / plantations
8	Narrow sand beach, some small mudflats / seawall / plantations, habitations
9	Broad mudflats, mangroves / seawall / farmland, some forest
10	Sand beaches, broad tough mudflats, mangroves / forest
11	Broad mudflats, mangroves / scrub, farmland
12	Broad mudflats with some sand, some mangroves / scrub, farmland, habitations
13	Broad sandflats with some mud / scrub, farmland

Table 8.5
Summary totals of Nearctic shorebirds in Suriname

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Unclassified shorebirds	Total shorebirds
Suriname	369.8					
No. of birds		1 346 625	148 168	21 536	10 000	1 526 329
% of size-class total (North Coast)		64.47	44.22	35.49	77.45	61.11
% of grand total (North Coast)		53.92	5.93	0.86	0.40	61.11
% of size-class total (South America)		57.85	32.42	17.75	76.31	52.28
% of grand total (South America)		46.13	5.08	0.74	0.34	52.28

Table 8.6*a*
Totals of Nearctic shorebird species in Suriname—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Suriname	369.8				
No. of birds		10	42	1 346 573	1 346 625
% of species total (North Coast)		2.78	0.96	64.63	64.47
% of size-class total (North Coast)		0.00	0.00	64.47	64.47
% of grand total (North Coast)		0.00	0.00	53.92	53.92
% of species total (South America)		2.32	0.04	60.86	57.85
% of size-class total (South America)		0.00	0.00	57.85	57.85
% of grand total (South America)		0.00	0.00	46.13	46.13

Table 8.6*b*
Totals of Nearctic shorebird species in Suriname—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Suriname	369.8						
No. of birds		3 940	619	66 377	21 840	55 392	148 168
% of species total (North Coast)		16.57	3.06	80.28	46.05	36.45	44.22
% of size-class total (North Coast)		1.18	0.18	19.81	6.52	16.53	44.22
% of grand total (North Coast)		0.16	0.02	2.66	0.87	2.22	5.93
% of species total (South America)		14.45	2.63	72.82	44.70	29.84	32.42
% of size-class total (South America)		0.86	0.14	14.52	4.78	12.12	32.42
% of grand total (South America)		0.13	0.02	2.27	0.75	1.90	5.08

Table 8.6*c*
Totals of Nearctic shorebird species in Suriname—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Unidentified large shorebird species	Total large shorebirds
Suriname	369.8				
No. of birds		3 310	15 646	2 580	21 536
% of species total (North Coast)		21.69	39.47	44.68	35.49
% of size-class total (North Coast)		5.45	25.78	4.25	35.49
% of grand total (North Coast)		0.13	0.63	0.10	0.86
% of species total (South America)		13.31	35.26	39.46	17.75
% of size-class total (South America)		2.73	12.90	2.13	17.75
% of grand total (South America)		0.11	0.54	0.09	0.74

Coast of Suriname. Vast mudflats, consisting of sediments discharged from the Amazon River, occur along the coast of Suriname and form one of the most important areas for shorebirds in South America.

dowitchers were found in the central parts of the coastline (Table 8.7). Distributional considerations and ground observations indicate that dowitchers in Suriname are Short-billed Dowitchers *Limnodromus griseus* (Blake 1977; Spaans 1978). Black-bellied Plovers also occurred in significant numbers (3900, 16.6 and 14.5% of the North Coast and South American totals, respectively; Table 8.6*b*). Black-bellied Plovers tended to occur in largest numbers in sectors containing extensive intertidal flats and less commonly in coastal lagoons or on sections of coast with sand or shell beaches or tough mudbanks. Turnstones were found regularly on tough mud sections, with moderate numbers along the coast (620, 3.1 and 2.6% as above; Table 8.6*b*). Some 55 400, or 37.4%, of the medium-sized shorebird total were not identified to species: such birds will have consisted principally of a mixture of the species discussed above. Suriname held a significant proportion of birds in this unidentified category, with 36.5 and 29.8% of the North Coast and South American totals, respectively.

Suriname was also of critical importance for large species, higher numbers being found only along the north-central coast of Brazil. All but 2600 (12.0%) of the total of 21 500 were identified to species (Table 8.6*c*). Both Willet *Catoptrophorus semipalmatus* (15 600) and Whimbrel *Numenius phaeopus* (3300) occurred in significant numbers, with 39.5/35.3% and 21.7/13.3% of the North Coast/South American totals, respectively. Both species tended to be slightly more common in the western part of the coastline (Table 8.7).

The largest concentrations of shorebirds in Suriname occurred on those sections of coast with broad intertidal flats backed by mangrove forests (Table 8.8). Relatively few birds were found in the lagoon areas adjacent to the coast that were surveyed (Bigi Pan Lagoons [Sector 3] and Matapica Lagoons [Sector 10]), the total for these areas (5300) making up only 0.3% of the overall total for the country. Conditions in these lagoons vary considerably during the year depending on rainfall and tidal flooding, and they do provide important roosting areas for shorebirds on high spring tides, when the coastal flats may be completely covered (Morrison and Spaans 1978). Other sectors with relatively low totals—Sectors 1, 4, and 9—contained a high proportion of sand/shell beaches or tough mudbanks with relatively little development of intertidal flats. Such areas supported moderate numbers of Ruddy Turnstones *Arenaria interpres*. The only flock of Sanderlings *Calidris alba* observed was found on the sand beaches in Sector 4. Sanderlings were also found only in small numbers on surveys in March 1981, in sandy beach sections in eastern Suriname (Morrison *et al.* 1985).

The most important areas for small shorebirds were the Wia-Wia Bank and other mudflats in eastern Suriname. The eastern four sectors (11–14) contained 698 000 or 51.9% of the total of 1 347 000 small shorebirds, and 732 000 or 47.9% of all shorebirds in the country (Table 8.7).

Map 8.2 (Suriname)
Distribution of Nearctic shorebirds on the coast of Suriname

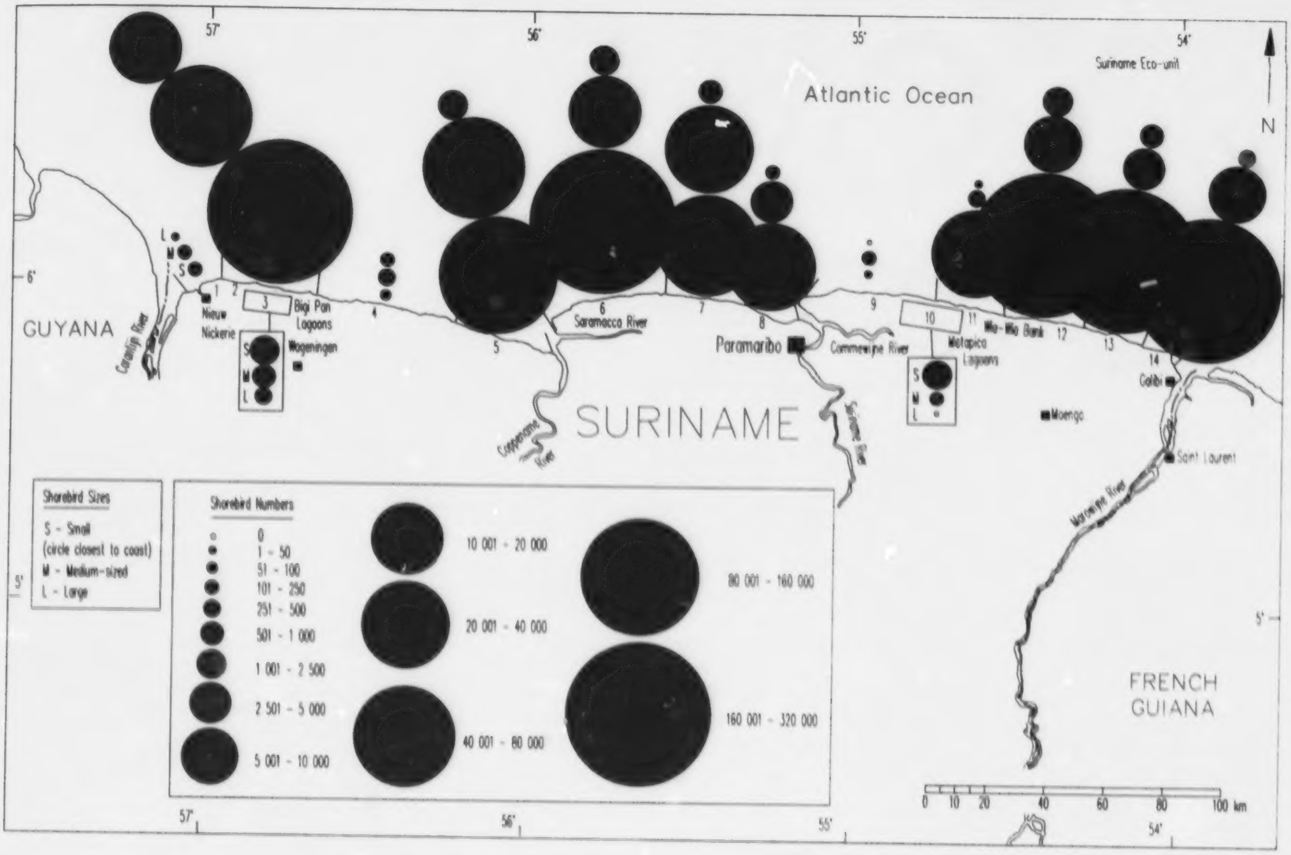

57°
56°
55°
54°
Suriname Eco-unit
Atlantic Ocean
N
6°
GUYANA
Corantijn River
L
M
S
1
2
Nieuw Nickerie
3
Bigi Pan Lagoons
Wageningen
4
5
6
Saramacca River
7
8
Paramaribo
Commewijne River
9
10
11
Wia-Wia Bank
12
13
14
Matapica Lagoons
Galibi
Moengo
SURINAME
Coppename River
Suriname River
Saint Laurent
Marowijne River
FRENCH GUIANA
5°
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
80 001 - 160 000
160 001 - 320 000
0
10
20
40
60
80
100 km

Table 8.7
Totals of Nearctic shorebirds in survey sectors in Map 8.2 (Suriname)

Sector no.	Sector length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Unidentified large shorebird species	Total large shorebirds	Unclassified shorebirds	Total shorebirds
1	12.6	1	0	200	201	6	55	78	0	0	139	19	2	6	27	0	367
2	53.9	0	0	220 050	220 050	641	83	14 281	0	27 120	42 125	1 724	10 148	2 080	13 952	0	276 127
3	0.0	0	0	1 660	1 660	0	0	547	0	0	547	2	426	0	428	0	2 635
4	27.6	2	42	32	76	20	239	3	0	20	282	37	211	0	248	0	606
5	31.6	0	0	140 520	140 520	325	190	22 305	12 200	6 450	41 470	223	590	394	1 207	0	183 197
6	38.7	0	0	201 667	201 667	280	1	6 872	1 160	4 490	12 803	470	1 870	0	2 340	0	216 810
7	34.2	2	0	55 000	55 002	312	1	11 757	7 380	7 400	26 850	212	527	0	739	0	82 591
8	28.3	3	0	26 602	26 605	271	40	1 160	1 000	100	2 571	170	0	50	220	0	29 396
9	32.3	2	0	0	2	0	9	3	0	111	123	0	0	0	0	0	125
10	0.0	0	0	2 500	2 500	0	0	185	0	0	185	0	0	0	0	0	2 685
11	29.4	0	0	32 002	32 002	0	0	184	0	209	393	1	40	0	41	0	32 436
12	32.9	0	0	246 210	246 210	1 623	0	2 601	100	3 527	7 851	43	1 311	0	1 354	0	255 415
13	33.7	0	0	177 450	177 450	175	0	1 690	0	2 965	4 830	379	255	0	634	0	182 914
14	14.6	0	0	242 680	242 680	287	1	4 711	0	3 000	7 999	30	266	50	346	10 000	261 025
Total	369.8	10	42	1 346 573	1 346 625	3 940	619	66 377	21 840	55 392	148 168	3 310	15 646	2 580	21 536	10 000	1 526 329

Table 8.8
Principal habitats in survey sectors in Map 8.2 (Suriname)

Sector no.	Habitat description
1	Broad mud beach with tough mudbanks / scrub, wetlands
2	Broad mudflats and banks, mangroves / forest, lagoons
3	Inland; brackish wetland with muddy areas, mangroves / farmland, forest
4	Broad tough mudbanks beach backed by sand beach, some mangroves / scrubby forest, rice fields
5	Broad mudflats, mangroves / forest
6	Broad mudflats, mangroves / forest
7	Tough mudflats with mangroves, some sandflats / forest
8	Broad tough mudbanks, some mudflats and sand beach, mangroves / forest, rice fields
9	Sand beach, tough mudbanks, mangroves / forest, lagoons
10	Inland; brackish wetland, muddy areas, mangroves / flooded plantations, forest
11	Sand beach, some broad mudflats, mangroves / forest, lagoons
12	Broad soft mudflats, mangroves / forest
13	Broad soft mudflats, some tough banks, mangroves / forest
14	Broad mudflats, some sand beaches, mangroves / forest, open scrub

In March 1981, survey totals for small shorebirds in the eastern four sectors (721 000) were very similar (3% difference) to the total in February 1982 (Morrison *et al.* 1985).

Very large numbers of shorebirds were also found on the central and western parts of the coast of Suriname, especially in the Coppename Mouth Nature Reserve east of the mouth of the Coppename and Saramacca rivers, the Coppename Bank area to the west of the mouth of the Coppename River, and the coastal stretch to the east of Nieuw Nickerie in the west of the country. The central sections of the country, in particular, supported high numbers of a variety of species of all size classes, as did the Nieuw Nickerie section (Sector 2), the latter area having the highest overall sector total for Suriname.

In addition to its importance as a wintering area, Suriname is also a very important area for shorebirds on migration. Many species have been observed migrating eastwards along the coast during the autumn (Spaans 1978; Morrison and Spaans 1978). Species such as the Red Knot *Calidris canutus*, which were not identified during the winter surveys in 1982, have been observed during both spring (720 during surveys in March 1981; Morrison *et al.* 1985) and autumn (Spaans 1978; Morrison and Spaans 1978; Harrington and Leddy 1982) migration.

8.4. French Guiana eco-unit

Sectors 1–11; Map 8.3 (French Guiana)

In terms of overall numbers, French Guiana was the second most important area for Nearctic shorebirds in South America after neighbouring Suriname, the total of some 431 000 representing 17.3% of the North Coast total and 14.8% of the overall total for South America. Small shorebirds made up 91.5% of the total, medium-sized species 7.6%, and large species 0.5%; a further 1500 (0.3%) shorebirds were not classified by size (Table 8.9).

French Guiana was of particular importance for small shorebirds, the total of over 394 000 representing 18.9% of the North Coast total or 16.9% of the South American total (Table 8.10*a*). Significant numbers of medium-sized species were also recorded, the total of 32 900 representing 9.8% of the North Coast total (7.2% of the South American total) (Table 8.10*b*). This included 5100 yellowlegs and 2400 dowitchers (6.2 and 5.1% of relevant North Coast totals, respectively), and it is likely that considerably more of these species were among the 24 100 medium-sized shorebirds not identified to species. Moderate numbers of large species (2100, 3.5% of the North Coast total), mostly Willets and Whimbrels, were also recorded (Table 8.10*c*).

The majority of shorebirds occurred along sectors of coast with broad mudflats backed by mangroves and marshes or lagoons. Such areas occurred most extensively in western French Guiana, especially in Sectors 2–4, which held 61.8% of the country total (Tables 8.11 and 8.12): this included 61.0 and 72.1% of the respective country totals for small and medium-sized shorebirds. Fewer shorebirds were found in Sector 1, which contained sandy beaches and fewer sections of flats, or Sectors 5 and 7, which appeared to be erosional coastlines with tough mudbanks and dying mangrove stands. No shorebirds were seen in the vicinity of Cayenne (Sector 8), where the Precambrian basement rocks outcrop at the coast. Intertidal flats were better developed again east of the Mahury River and Approuague River in Sectors 9 and 10, where coastal plain sediments have accumulated, and larger numbers of shorebirds were once more encountered. The coastline in Sector 11 leading into the estuary of the Rio Oiapoque was composed of tough mud with forest to the edge of the water, and fewer shorebirds were seen.

Table 8.9
Summary totals of Nearctic shorebirds in French Guiana

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Unclassified shorebirds	Total shorebirds
French Guiana	388.2					
No. of birds		394 334	32 906	2 094	1 500	430 834
% of size-class total (North Coast)		18.88	9.82	3.45	11.62	17.25
% of grand total (North Coast)		15.79	1.32	0.08	0.06	17.25
% of size-class total (South America)		16.94	7.20	1.73	11.45	14.76
% of grand total (South America)		13.51	1.13	0.07	0.05	14.76

Table 8.10*a*
Totals of Nearctic shorebird species in French Guiana—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
French Guiana	388.2				
No. of birds		5	2	394 327	394 334
% of species total (North Coast)		1.39	0.05	18.93	18.88
% of size-class total (North Coast)		0.00	0.00	18.88	18.88
% of grand total (North Coast)		0.00	0.00	15.79	15.79
% of species total (South America)		1.16	0.00	17.82	16.94
% of size-class total (South America)		0.00	0.00	16.94	16.94
% of grand total (South America)		0.00	0.00	13.51	13.51

Table 8.10*b*
Totals of Nearctic shorebird species in French Guiana—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
French Guiana	388.2						
No. of birds		640	601	5 117	2 400	24 148	32 906
% of species total (North Coast)		2.69	2.97	6.19	5.06	15.89	9.82
% of size-class total (North Coast)		0.19	0.18	1.53	0.72	7.21	9.82
% of grand total (North Coast)		0.03	0.02	0.20	0.10	0.97	1.32
% of species total (South America)		2.35	2.56	5.61	4.91	13.01	7.20
% of size-class total (South America)		0.14	0.13	1.12	0.53	5.28	7.20
% of grand total (South America)		0.02	0.02	0.18	0.08	0.83	1.13

Table 8.10*c*
Totals of Nearctic shorebird species in French Guiana—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Unidentified large shorebird species	Total large shorebirds
French Guiana	388.2				
No. of birds		326	729	1 039	2 094
% of species total (North Coast)		2.14	1.84	17.99	3.45
% of size-class total (North Coast)		0.54	1.20	1.71	3.45
% of grand total (North Coast)		0.01	0.03	0.04	0.08
% of species total (South America)		1.31	1.64	15.89	1.73
% of size-class total (South America)		0.27	0.60	0.86	1.73
% of grand total (South America)		0.01	0.02	0.04	0.07

Map 8.3 (French Guiana)
Distribution of Nearctic shorebirds on the coast of French Guiana

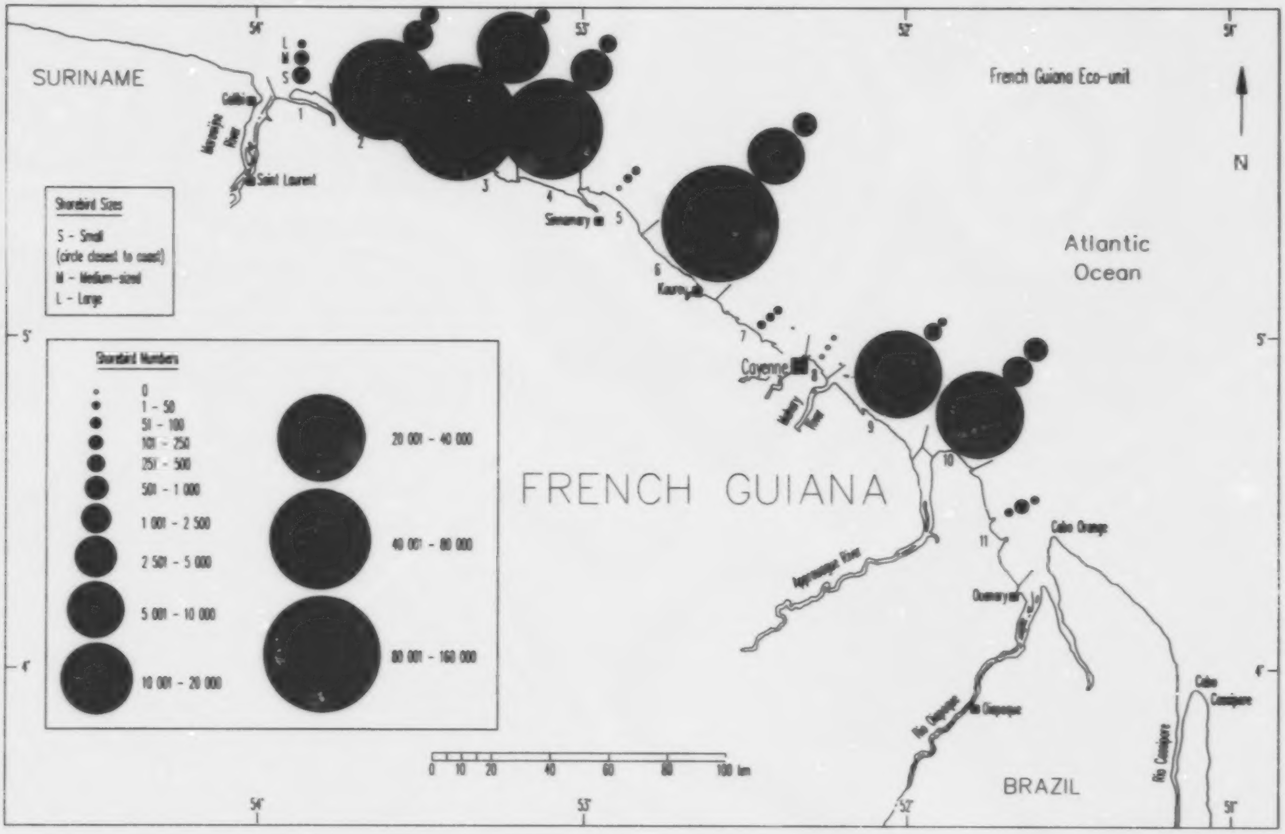

SURINAME
FRENCH GUIANA
BRAZIL
Atlantic
Ocean
French Guiana Eco-unit
N
54°
53°
52°
51°
5°
4°
L
M
S
Galibi
Maroni River
Saint Laurent
Sinnamary
Kourou
Cayenne
Cabo Orange
Oiapoque
Cabo Cassipore
Rio Cassipore
1
2
3
4
5
6
7
8
9
10
11
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
40 001 - 80 000
80 001 - 160 000
0 10 20 40 60 80 100 km

Table 8.11
Totals of Nearctic shorebirds in survey sectors in Map 8.3 (French Guiana)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Dowit-cher species	Uniden-tified medium-sized shorebird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Unclas-sified shore-birds	Total shore-birds
1	22.4	0	0	480	480	11	0	40	0	54	105	1	0	0	1	0	586
2	29.6	0	2	65 445	65 447	146	3	87	0	2 110	2 346	90	255	32	377	0	68 170
3	42.1	0	0	107 854	107 854	10	555	773	0	16 190	17 528	58	96	0	154	1 500	127 036
4	46.3	0	0	67 110	67 110	25	0	226	0	3 575	3 826	50	225	0	275	0	71 211
5	29.6	0	0	0	0	20	0	0	0	0	20	20	0	0	20	0	40
6	55.7	0	0	100 950	100 950	53	42	2 890	2 400	999	6 384	52	141	352	545	0	107 879
7	40.0	3	0	0	3	15	0	0	0	0	15	17	0	0	17	0	35
8	15.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	41.4	2	0	24 128	24 130	125	1	270	0	75	471	8	0	20	28	0	24 629
10	19.2	0	0	28 340	28 340	225	0	720	0	1 135	2 080	4	11	635	650	0	31 070
11	46.7	0	0	20	20	10	0	111	0	10	131	26	1	0	27	0	178
Total	388.2	5	2	394 327	394 334	640	601	5 117	2 400	24 148	32 906	326	729	1 039	2 094	1 500	430 834

Table 8.12
Principal habitats in survey sectors in Map 8.3 (French Guiana)

Sector no.	Habitat description
1	Sand beach and broad mudflats with mangroves / forest, lagoons, scrub
2	Sand beach and spits, mudbanks and flats, some mangroves / forest, lagoons, scrub
3	Broad mudflats and banks, some sand beaches / marsh, palms, forest
4	Tough mudbanks and flats, mangroves / marsh, scrub
5	Tough mudbanks, mangroves (some dead) / grassland, marsh, forest
6	Sand beach, broad mudflats, mangroves / marsh, forest
7	Tough mudbanks, mangroves / forest
8	Sand beach, rocky headlands / forest, habitations
9	Broad mudflats, some tough mudbanks, mangroves / forest
10	Broad mudflats, mangroves / forest
11	Tough mudbanks, mangroves / scrub, palms

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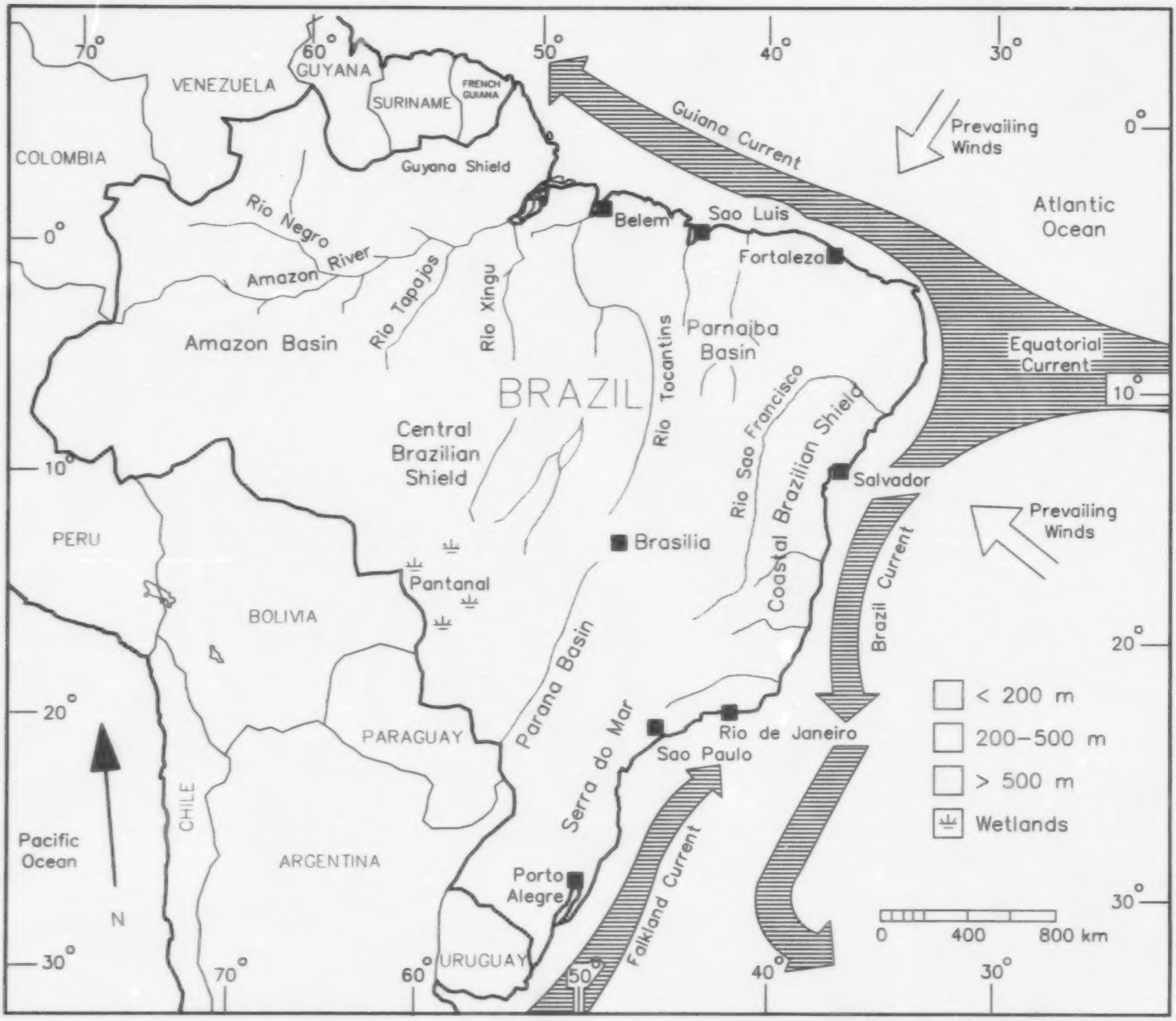
Figure 9.1
Some of the main geographical features of Brazil



VENEZUELA
GUYANA
SURINAME
FRENCH GUIANA
COLOMBIA
Guyana Shield
Guiana Current
Prevailing Winds
Atlantic Ocean
Rio Negro
Amazon River
Rio Tapajos
Rio Xingu
Belem
Sao Luis
Fortaleza
Amazon Basin
Parnaiba Basin
Equatorial Current
BRAZIL
Rio Tocantins
Rio Sao Francisco
Coastal Brazilian Shield
Central Brazilian Shield
Salvador
Prevailing Winds
PERU
Brasilia
Pantanal
BOLIVIA
Brazil Current
Parana Basin
PARAGUAY
Serra do Mar
Sao Paulo
Rio de Janeiro
CHILE
Pacific Ocean
ARGENTINA
Porto Alegre
Falkland Current
URUGUAY
N
< 200 m
200–500 m
> 500 m
Wetlands
0
400
800 km
70°
60°
50°
40°
30°
0°
10°
20°
30°

Chapter 9

Brazil

R.I.G. Morrison, R.K. Ross, and Paulo T.Z. Antas

9.1. General geography

Brazil is the largest country in South America, in terms of both geography and population. It has a surface area of over 8.51 × 10^6 km^2, approximately half the area of the South American continent, and is the fifth largest country in the world. Brazil shares common borders with all but two countries in South America (Ecuador and Chile), and its population of some 135 million, the eighth largest in the world, is over half that of South America. Brazil is about 4320 km from north to south and 4330 km from east to west (Brooks 1985) and lies between 5°N and 34°S and between 35 and 74°W.

The coastline of Brazil is some 9200 km long and lies roughly between 4°N and 34°S. It contains a wide variety of morphologies, environments, and sediments, which are determined not only by the geological structure of the immediate coastal area, but also by that of the hinterland drainage areas, as well as oceanographic and climatic factors. The entire coastline, and indeed nearly all of Brazil, is underlain by the Precambrian rocks of the Brazilian Platform, the major geotectonic unit on which much of the continent between the Orinoco River and the Rio de la Plata is situated. The Brazilian Platform outcrops in three major shields, which form the major structural plateaus of northern South America (Harrington 1956) (Fig. 9.1): (1) the Guiana Shield, located to the north of the Amazon River and extending through northwestern Brazil along the borders with the Guianas and Venezuela; (2) the Central Brazilian Shield south of the Amazon River; and (3) the Coastal Brazilian (Atlantic) Shield, extending all along the eastern coastal margin of the country. These shields are composed of very old, hard crystalline rocks, dating back more than 1800 million years BP (Almeida *et al.* 1973), although they are partly overlain in some areas by later sedimentary rocks. Between the shields lie enormous basins containing the huge areas of the major river drainage systems. The two most important are the Amazon River system, occupying the vast Amazon Basin between the Guiana and Central Brazilian shields, and the Parana/Paraguay river system, which is situated between the Andes and the southern part of the Coastal Brazilian (Atlantic) Shield. Other principal geological basins include the Sao Francisco Basin, containing the third largest river system in Brazil, lying between the Central and Coastal Brazilian (Atlantic) shields, and the Parnaiba (or Maranhao) Basin to its north, extending towards the north coast (Fig. 9.1).

The Amazon is the largest river in the world, in terms of both drainage area and volume of water discharged (Gibbs 1967; Lisitzin 1972). The basin containing the vast network of tributaries making up the Amazon system is roughly bottle-shaped, trending in an east-northeasterly direction, being some 3000 km long, 600–800 km wide at its upper west end, and 300 km wide towards the narrow eastern end (Bigarella 1973). The entire area is very low-lying, most of it below 200 m in elevation. Rainfall is generally high, varying between 1500 and 3000 mm · yr^{-1}, with a rainy season occurring between October and May in the central and eastern sections. Peak river flow occurs in June, with tributaries to the north of the Amazon reaching peaks between June and August and those to the south between February and June (Junk 1983; Scott and Carbonell 1986). Together with the Tocantins, the Amazon and Parana/la Plata systems drain almost 80% of Brazil and, because of the aridity of the northeastern rivers, account for about 90% of the runoff and suspended load of sediments reaching the Brazilian coast (Milliman 1975).

Most of the sediment reaching the mouth of the Amazon is derived from the hard crystalline rocks of the Andes: some 84% of the discharged material derives from about 12% of the drainage area in the Andes, and the overall compositions of the sediments discharged at the mouth of the river and of those eroded from the mountainous environment differ only slightly (Gibbs 1967). Although the concentration of suspended material in the Amazon is not particularly high compared with those in other world rivers, the amount of material reaching the sea is very large: an estimated 500 × 10^6 tons · yr^{-1} from the 5500 km^3 of water discharged each year (Milliman 1975). Amazon sediments are carried northwestwards by the North Equatorial (Guiana) Current for some 2000 km in a belt averaging 60 km in width (Gibbs 1970*a*) and are deposited along the north coast of South America from northern Brazil and the Guianas to the Orinoco River in Venezuela. These coastlines are generally low and flat, with extensive mangrove forests and swamps and rather mobile intertidal mud- and sandflats.

In the mouth of the Amazon itself, discharge is so high that a saltwater wedge does not enter the river, resulting in an essentially freshwater environment, even during periods of low river discharge (Gibbs 1970*b*). Currents are strong and the tidal range high. Most intertidal areas consist of sandflats, and the low coast is backed by palm (*Euterpe oleracea* and *Mauritia flexuosa*) forests and open swamps.

East of the mouth of the Amazon River, the coastline between Belem and Sao Luis is highly indented. Shallow bays, which contain large areas of intertidal flats and are lined with extensive mangrove forests, alternate with sandy outer headlands fronted by ocean beaches. These areas represent drowned river valleys being reinvaded by the sea and contain a wide variety of sediment and habitat types.

Beyond the Baia de Sanadi east of Sao Luis, the coastline becomes smoother and straighter. It is generally sandy, beach ridges and dunes alternating with occasional embayments and estuaries, which are restricted to the mouths of the larger (and some of the smaller) rivers. Although the larger rivers flow year-round, many of the smaller rivers in the arid northeast dry up. Much of the hinterland is arid and sparsely vegetated and consists of scrubland.

The eastern Atlantic coastline is backed by mountains of the Precambrian Coastal Brazilian (Atlantic) Shield, which reach heights of 500–1000 m. The coastal plain is generally fairly narrow, and parts of the shoreline are cliffed. Rainfall is high, usually exceeding 1000 $\mathrm{mm \cdot yr^{-1}}$ and sometimes 2000 $\mathrm{mm \cdot yr^{-1}}$, where the prevailing easterly and southeasterly winds deposit their moisture (Andrade 1964). The Rio Sao Francisco is the principal river; it is about 2700 km in length and provides the major source of sediment and freshwater input on the coast. Most of the sediment appears to remain within its own system, as with other rivers on the coast (Barretto and Summerhayes 1975; Summerhayes *et al.* 1975). The offshore waters are generally unproductive (Okada 1960; Hela and Laevastu 1962); even near the Rio Sao Francisco, which provides most of the nutrient and sediment input on this part of the coast, most organic matter (mainly diatoms) appears to be recycled within the water column, with only a small amount accumulating in the sediment (Barretto and Summerhayes 1975).

Much of the Atlantic coast is similar, with a coastal plain of variable width interrupted by occasional river deltas or outcroppings of the underlying Precambrian rocks. Parts of the coast are lined with reefs of beachrock, and barrier beaches develop under the influence of waves produced by the prevailing southeasterly trade winds. Rivers are generally short, owing to the proximity of the mountains of the Coastal Brazilian (Atlantic) Shield. Mangroves may develop in embayments (e.g., in the area of Salvador) or behind protective barrier beaches.

The crystalline basement rocks continue southwards into Rio Grande do Sul, nearing the coast in the ranges of the Serra do Mar and Serra Geral formations, which reach heights of 1000 m and in some places over 1900 m (Fuck *et al.* 1969). With the mountain ranges close to the sea, most of the rivers in the southern part of the country flow westwards into the Parana River system.

In the south, the coastline of Rio Grande do Sul forms one of the longest uninterrupted beaches in the world, being some 620 km in length (Martins 1967; Pinto and Ornellas 1970). A number of major lagoons lie behind the coast, the largest being the Lagoa dos Patos and the Lagoa Mirim. These are separated from the ocean by several kilometres of marine and eolian sands, in which are found numerous smaller lagoons. Some of the lagoons are periodically connected to the sea and are hence partially brackish; such lagoons (e.g., the Lagoa do Peixe) form important habitats for wintering and migrant birds (Morrison *et al.* 1985; Harrington *et al.* 1986).

Offshore, the west-flowing South Equatorial Current reaches the coast of Brazil to the north of Recife (Defaut 1961). The current splits, with the North Brazilian Coastal Current flowing north past Natal and then west along the north coast as the North Equatorial (Guiana) Current at about 1 $\mathrm{m \cdot s^{-1}}$ (Metcalf and Stalcup 1967), and the Brazil Current flowing southwards towards Rio de Janeiro at about 0.25–0.5 $\mathrm{m \cdot s^{-1}}$. Surface temperatures range between 26 and 29°C in summer (March; Fuglister 1960) and between 25 and 27°C in winter (August; Cavalcanti *et al.* 1967). Salinities are around 36 ppt. The Brazil Current flows south to about 30°S, where it meets the colder and less saline Falkland (Malvinas) Current moving north from the southern ocean. The Falkland (Malvinas) Current extends progressively northwards in the autumn under the influence of southwesterly winds, reaching its maximum development during the southern winter, when cool waters invade north of Santa Catarina state, dipping below the surface before upwelling at Cabo Frio. In the spring, winds shift to northeast, and the Brazil Current again dominates the coastal circulation (Emilsson 1961). After meeting, the two currents turn east to flow back across the South Atlantic, thus completing the counterclockwise circulation of the South Atlantic Ocean (King 1975). Cabo Frio (23°S) marks the northernmost limit reached by cooler waters from the south. Upwelling is strong in the Cabo Frio area, and, with the incursion of cold water, biological productivity is relatively high thereabouts (Okuda 1962). Bottom sediments in the area show slightly elevated levels of nitrogen, but the impact of upwelling is not clearly shown in the sediments, probably because the high wave and current energies and high oxygen levels occurring between Cabo Frio and Vitoria facilitate high levels of recycling of organic matter within the water column (da Rocha *et al.* 1975). Ocean productivity increases southwards beyond Cabo Frio (Peres 1982). In contrast, waters off the northern part of the coast are generally unproductive (Okada 1960; Hela and Laevastu 1962).

9.2. Shorebird distribution

Brazil supported the third highest overall total of Nearctic shorebirds recorded on the surveys: of the total of 398 000, 63.5% were small shorebirds, 27.2% were medium-sized birds, and 8.8% were large species. These totals represented highly significant proportions of the South American totals for each category: 13.6% of the total Nearctic shorebirds, and 10.9, 24.1, and 29.0% of the small, medium-sized, and large categories, respectively (Table 9.1).

Two regions of Brazil stood out clearly as being of special importance for shorebirds. The most spectacular area was the north-central coast of Brazil between Belem and the Sao Luis area, which held major proportions of the wintering populations of a number of species (Morrison *et al.* 1986*a*, 1986*b*). The shoreline and coastal lagoons of Rio Grande do Sul in the south were of special importance both as a wintering area and as a staging area for birds on migration (Morrison *et al.* 1985; Harrington *et al.* 1986).

9.2.1. North-central coast of Brazil

This section of coast is highly indented and hence very long; it contains a series of bays and headlands with a wide variety of habitats, from extensive muddy intertidal areas lined with mangroves in the inner parts of the bays, through tough mudbanks, sandy and muddy flats and marsh developments in the middle parts of the bays, to sandy outer headlands with ocean beaches and spits (Morrison *et al.* 1987). This highly productive area sup-

Table 9.1
Summary totals of Nearctic shorebirds in eco-units in Brazil

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
North	464.3				
No. of birds		25 598	2 323	674	28 595
% of size-class total (Brazil)		10.13	2.11	1.92	7.18
% of size-class total (South America)		1.10	0.51	0.56	0.98
% of size-class total (North Coast)		1.23	0.69	1.11	1.14
% of grand total (North Coast)		1.02	0.09	0.03	1.14
Amazon	633.8				
No. of birds		2 080	621	7	2 708
% of size-class total (Brazil)		0.82	0.56	0.02	0.68
% of size-class total (South America)		0.09	0.14	0.01	0.09
% of size-class total (North Coast)		0.10	0.19	0.01	0.11
% of grand total (North Coast)		0.08	0.02	0.00	0.11
North-central	2 504.7				
No. of birds		195 531	97 227	34 133	326 891
% of size-class total (Brazil)		77.34	88.18	97.11	82.09
% of size-class total (South America)		8.40	21.27	28.14	11.20
% of size-class total (North Coast)		9.36	29.01	56.25	13.09
% of grand total (North Coast)		7.83	3.89	1.37	13.09
Northeast	1 248.4				
No. of birds		3 009	2 760	183	5 952
% of size-class total (Brazil)		1.19	2.50	0.52	1.49
% of size-class total (South America)		0.13	0.60	0.15	0.20
% of size-class total (North Coast)		0.14	0.82	0.30	0.24
% of grand total (North Coast)		0.12	0.11	0.01	0.24
East	939.0				
No. of birds		1 817	679	143	2 639
% of size-class total (Brazil)		0.72	0.62	0.41	0.66
% of size-class total (South America)		0.08	0.15	0.12	0.09
% of size-class total (Atlantic Coast)		2.21	0.77	0.43	1.30
% of grand total (Atlantic Coast)		0.89	0.33	0.07	1.30
Rio	394.9				
No. of birds		688	4 885	0	5 573
% of size-class total (Brazil)		0.27	4.43	0.00	1.40
% of size-class total (South America)		0.03	1.07	0.00	0.19
% of size-class total (Atlantic Coast)		0.84	5.57	0.00	2.74
% of grand total (Atlantic Coast)		0.34	2.40	0.00	2.74
Sao Paulo	784.5				
No. of birds		11	1	0	12
% of size-class total (Brazil)		0.00	0.00	0.00	0.00
% of size-class total (South America)		0.00	0.00	0.00	0.00
% of size-class total (Atlantic Coast)		0.01	0.00	0.00	0.01
% of grand total (Atlantic Coast)		0.01	0.00	0.00	0.01
Rio Grande do Sul	882.9				
No. of birds		24 078	1 762	7	25 847
% of size-class total (Brazil)		9.52	1.60	0.02	6.49
% of size-class total (South America)		1.03	0.39	0.01	0.89
% of size-class total (Atlantic Coast)		29.23	2.01	0.02	12.71
% of grand total (Atlantic Coast)		11.84	0.87	0.00	12.71
All Brazil	7 852.5				
No. of birds		252 812	110 258	35 147	398 217
% of size-class total (South America)		10.86	24.12	28.97	13.64
% of grand total (South America)		8.66	3.78	1.20	13.64

ported 327 000 shorebirds (82.1% of the Brazilian total), including 196 000 small, 97 200 medium-sized, and 34 100 large shorebirds (77.3, 88.2, and 97.1% of the respective Brazilian size-class totals) (Table 9.1). These North-central eco-unit size-class totals represented 8.4, 21.3, and 28.1% of the respective South American totals (9.4, 29.0, and 56.3% of the respective North Coast totals) (Table 9.1), identifying the area as being of major international importance. The small shorebird category included 192 000 peeps (9.2% of the North Coast total, 8.7% of the South American total) and consisted principally of Semipalmated Sandpipers *Calidris pusilla*, with smaller numbers of other *Calidris* sandpipers (e.g., Least Sandpipers *C. minutilla*) and small plovers in the genus *Charadrius*. The area was regionally important for Sanderlings *Calidris alba*, supporting 70.5% (3100, 2.8% of the South American total) of the birds on the North Coast (Table 9.2*a*).

The north-central coast contained the most important wintering areas discovered on the continent for Ruddy Turnstones *Arenaria interpres* and Black-bellied Plovers *Pluvialis squatarola*. Ruddy Turnstones were especially common on the tough mudbanks and mangrove coasts of the area, the total of 17 900 representing 76.2% of the South American total (88.5% of the North Coast total), making the area of major international importance for this species (Table 9.2*b*). The complexes of large intertidal flats and beaches, providing both plentiful feeding and roosting habitats, attracted large numbers of Black-bellied Plovers, the total of 14 700 being 54.0% of the South American total (61.9% of the North Coast total). The area was also notable for Red Knot *Calidris canutus*, supporting the only substantial concentration (8200) discovered outside the main wintering areas in Tierra del Fuego and Patagonia.

Table 9.2*a*
Totals of Nearctic shorebird species in eco-units in Brazil—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Semi-palmated Plover	Spotted Sandpiper	Solitary Sandpiper	Pectoral Sandpiper	White-rumped Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
North	464.3								
No. of birds		0	2	0	0	0	2	25 594	25 598
% of species total (North Coast)		0.00	0.56	0.00	0.00	0.00	0.05	1.23	1.23
% of species total (South America)		0.00	0.46	0.00	0.00	0.00	0.00	1.16	1.10
% of size-class total (North Coast)		0.00	0.00	0.00	0.00	0.00	0.00	1.23	1.23
% of grand total (North Coast)		0.00	0.00	0.00	0.00	0.00	0.00	1.02	1.02
Amazon	633.8								
No. of birds		470	4	0	0	0	117	1 489	2 080
% of species total (North Coast)		100.00	1.11	0.00	0.00	0.00	2.68	0.07	0.10
% of species total (South America)		100.00	0.93	0.00	0.00	0.00	0.10	0.07	0.09
% of size-class total (North Coast)		0.02	0.00	0.00	0.00	0.00	0.01	0.07	0.10
% of grand total (North Coast)		0.02	0.00	0.00	0.00	0.00	0.00	0.06	0.08
North-central	2 504.7								
No. of birds		0	246	1	0	0	3 080	192 204	195 531
% of species total (North Coast)		0.00	68.33	100.00	0.00	0.00	70.51	9.22	9.36
% of species total (South America)		0.00	57.08	50.00	0.00	0.00	2.75	8.69	8.40
% of size-class total (North Coast)		0.00	0.01	0.00	0.00	0.00	0.15	9.20	9.36
% of grand total (North Coast)		0.00	0.01	0.00	0.00	0.00	0.12	7.70	7.83
Northeast	1 248.4								
No. of birds		0	3	0	0	0	380	2 626	3 009
% of species total (North Coast)		0.00	0.83	0.00	0.00	0.00	8.70	0.13	0.14
% of species total (South America)		0.00	0.70	0.00	0.00	0.00	0.34	0.12	0.13
% of size-class total (North Coast)		0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.14
% of grand total (North Coast)		0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.12
East	939.0								
No. of birds		0	20	1	65	0	261	1 470	1 817
% of species total (Atlantic Coast)		0.00	80.00	100.00	98.48	0.00	2.81	2.08	2.21
% of species total (South America)		0.00	4.64	50.00	98.48	0.00	0.23	0.07	0.08
% of size-class total (Atlantic Coast)		0.00	0.02	0.00	0.08	0.00	0.32	1.78	2.21
% of grand total (Atlantic Coast)		0.00	0.01	0.00	0.03	0.00	0.13	0.72	0.89
Rio	394.9								
No. of birds		0	2	0	0	0	524	162	688
% of species total (Atlantic Coast)		0.00	8.00	0.00	0.00	0.00	5.65	0.23	0.84
% of species total (South America)		0.00	0.46	0.00	0.00	0.00	0.47	0.01	0.03
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.64	0.20	0.84
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.26	0.08	0.34
Sao Paulo	784.5								
No. of birds		0	0	0	0	0	0	11	11
% of species total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01
% of species total (South America)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Rio Grande do Sul	882.9								
No. of birds		0	0	0	1	2 340	6 618	15 119	24 078
% of species total (Atlantic Coast)		0.00	0.00	0.00	1.52	99.96	71.30	21.40	29.23
% of species total (South America)		0.00	0.00	0.00	1.52	99.96	5.92	0.68	1.03
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	2.84	8.03	18.35	29.23
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	1.15	3.25	7.43	11.84
All Brazil	7 852.5								
No. of birds		470	277	2	66	2 340	10 982	238 675	252 812
% of species total (South America)		100.00	64.27	100.0	100.0	99.96	9.82	10.79	10.86
% of size-class total (South America)		0.02	0.01	0.00	0.00	0.10	0.47	10.25	10.86
% of grand total (South America)		0.02	0.01	0.00	0.00	0.08	0.38	8.18	8.66

Dowitchers *Limnodromus* spp. were also numerous, with 16.6% (8100) of the South American total (17.1% of the North Coast total).

North-central Brazil was also the most important wintering area discovered in South America for two large species, Whimbrel *Numenius phaeopus* and Willet *Catoptrophorus semipalmatus*. Whimbrels were especially numerous, again favouring the tough mudbanks and flats of the area, the total of 10 900 representing 43.7% of the total for South America (71.3% of the North Coast total). Willets were also common along the mangrove coastlines, the total of 21 900 representing 49.3 and 55.2% of the South American and North Coast totals, respectively (Table 9.2*c*).

9.2.2. Rio Grande do Sul

The long, sandy ocean beaches of the coastline of Rio Grande do Sul in southern Brazil supported the highest numbers of Sanderlings (6600, 5.9% of the South American total) found on the Atlantic coast, with 71.3% of the regional Atlantic Coast total. This area and the north-central coast of Brazil supported the most significant concentrations of Sanderlings found outside the main wintering area of the species on the west coast of South America.

Nearshore brackish lagoons, such as the Lagoa do Peixe, were especially important as shorebird habitat. The Rio Grande do Sul eco-unit held 15 100 peeps, representing 21.4% of the Atlantic Coast total (Table 9.2*a*). The

Table 9.2*b*
Totals of Nearctic shorebird species in eco-units in Brazil—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Red Knot	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
North	464.3								
No. of birds		47	676	191	205	120	20	1 064	2 323
% of species total (North Coast)		36.43	2.84	0.94	0.25	1.36	0.04	0.70	0.69
% of species total (South America)		1.16	2.48	0.81	0.22	0.16	0.04	0.57	0.51
% of size-class total (North Coast)		0.01	0.20	0.06	0.06	0.04	0.01	0.32	0.69
% of grand total (North Coast)		0.00	0.03	0.01	0.01	0.00	0.00	0.04	0.09
Amazon	633.8								
No. of birds		0	101	4	227	0	150	139	621
% of species total (North Coast)		0.00	0.42	0.02	0.27	0.00	0.32	0.09	0.19
% of species total (South America)		0.00	0.37	0.02	0.25	0.00	0.31	0.07	0.14
% of size-class total (North Coast)		0.00	0.03	0.00	0.07	0.00	0.04	0.04	0.19
% of grand total (North Coast)		0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02
North-central	2 504.7								
No. of birds		0	14 711	17 909	803	8 191	8 105	47 508	97 227
% of species total (North Coast)		0.00	61.88	88.45	0.97	92.60	17.09	31.26	29.01
% of species total (South America)		0.00	53.95	76.21	0.88	10.72	16.59	25.59	21.27
% of size-class total (North Coast)		0.00	4.39	5.34	0.24	2.44	2.42	14.18	29.01
% of grand total (North Coast)		0.00	0.59	0.72	0.03	0.33	0.32	1.90	3.89
Northeast	1 248.4								
No. of birds		82	1 289	433	218	15	35	688	2 760
% of species total (North Coast)		63.57	5.42	2.14	0.26	0.17	0.07	0.45	0.82
% of species total (South America)		2.02	4.73	1.84	0.24	0.02	0.07	0.37	0.60
% of size-class total (North Coast)		0.02	0.38	0.13	0.07	0.00	0.01	0.21	0.82
% of grand total (North Coast)		0.00	0.05	0.02	0.01	0.00	0.00	0.03	0.11
East	939.0								
No. of birds		0	168	321	59	0	0	131	679
% of species total (Atlantic Coast)		0.00	27.01	35.75	0.97	0.00	0.00	1.52	0.77
% of species total (South America)		0.00	0.62	1.37	0.06	0.00	0.00	0.07	0.15
% of size-class total (Atlantic Coast)		0.00	0.19	0.37	0.07	0.00	0.00	0.15	0.77
% of grand total (Atlantic Coast)		0.00	0.08	0.16	0.03	0.00	0.00	0.06	0.33
Rio	394.9								
No. of birds		0	76	1	4 808	0	0	0	4 885
% of species total (Atlantic Coast)		0.00	12.22	0.11	78.78	0.00	0.00	0.00	5.57
% of species total (South America)		0.00	0.28	0.00	5.27	0.00	0.00	0.00	1.07
% of size-class total (Atlantic Coast)		0.00	0.09	0.00	5.48	0.00	0.00	0.00	5.57
% of grand total (Atlantic Coast)		0.00	0.04	0.00	2.36	0.00	0.00	0.00	2.40
Sao Paulo	784.5								
No. of birds		0	0	0	0	0	0	1	1
% of species total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
% of species total (South America)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rio Grande do Sul	882.9								
No. of birds		629	3	0	419	0	0	711	1 762
% of species total (Atlantic Coast)		16.08	0.48	0.00	6.87	0.00	0.00	8.26	2.01
% of species total (South America)		15.51	0.01	0.00	0.46	0.00	0.00	0.38	0.39
% of size-class total (Atlantic Coast)		0.72	0.00	0.00	0.48	0.00	0.00	0.81	2.01
% of grand total (Atlantic Coast)		0.31	0.00	0.00	0.21	0.00	0.00	0.35	0.87
All Brazil	7 852.5								
No. of birds		758	17 024	18 859	6 739	8 326	8 310	50 242	110 258
% of species total (South America)		18.69	62.43	80.25	7.39	10.90	17.01	27.06	24.12
% of size-class total (South America)		0.17	3.72	4.13	1.47	1.82	1.82	10.99	24.12
% of grand total (South America)		0.03	0.58	0.65	0.23	0.29	0.28	1.72	3.78

majority of peeps in this region are White-rumped Sandpipers *Calidris fuscicollis*; if the totals for these categories are combined, the Rio Grande do Sul coastline held 17 500, or 23.9% of the Atlantic Coast total, with 14 200 (81.6%) in lagoon habitats and 3200 (18.4%) on the coast. Lagoon and shoreline habitats in this area were also important for the Lesser Golden-Plover *Pluvialis dominica*; the total of 630 represented 16.1% of the Atlantic Coast total (Table 9.2*b*), although this species also makes widespread use of inland habitats. During ground surveys in February 1985, an estimated 6000–10 000 Lesser Golden-Plovers were found at the Lagoa do Peixe (unpubl. results). The area is also known to be of critical importance as a stopover site for Red Knots and Hudsonian Godwits *Limosa haemastica* during northward migration (unpubl. results; Harrington *et al.* 1986).

9.2.3. Other parts of the Brazilian coast

Numbers of shorebirds were smaller along other parts of the Brazilian coastline. In the north, the coast between the border with French Guiana and the mouth of the Amazon River contained moderate numbers of small shorebirds, mostly peeps (25 600, 10.1% of the Brazilian total, 1.2% of the North Coast total; Table 9.2*a*), and

Table 9.2*c*
Totals of Nearctic shorebird species in eco-units in Brazil—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds
North	464.3					
No. of birds		138	25	0	511	674
% of species total (North Coast)		0.90	0.06	0.00	8.85	1.11
% of species total (South America)		0.55	0.06	0.00	7.81	0.56
% of size-class total (North Coast)		0.23	0.04	0.00	0.84	1.11
% of grand total (North Coast)		0.01	0.00	0.00	0.02	0.03
Amazon	633.8					
No. of birds		0	0	0	2	2
% of species total (North Coast)		0.00	0.00	0.00	0.03	0.01
% of species total (South America)		0.00	0.00	0.00	0.03	0.01
% of size-class total (North Coast)		0.00	0.00	0.00	0.00	0.01
% of grand total (North Coast)		0.00	0.00	0.00	0.00	0.00
North-central	2 504.7					
No. of birds		10 879	21 868	4	1 382	34 133
% of species total (North Coast)		71.30	55.17	100.00	23.93	56.25
% of species total (South America)		43.74	49.29	0.01	21.13	28.14
% of size-class total (North Coast)		17.93	36.04	0.01	2.28	56.25
% of grand total (North Coast)		0.44	0.88	0.00	0.06	1.37
Northeast	1 248.4					
No. of birds		117	26	0	40	183
% of species total (North Coast)		0.77	0.07	0.00	0.69	0.30
% of species total (South America)		0.47	0.06	0.00	0.61	0.15
% of size-class total (North Coast)		0.19	0.04	0.00	0.07	0.30
% of grand total (North Coast)		0.00	0.00	0.00	0.00	0.01
East	939.0					
No. of birds		66	77	0	0	143
% of species total (Atlantic Coast)		31.43	100.00	0.00	0.00	0.43
% of species total (South America)		0.27	0.17	0.00	0.00	0.12
% of size-class total (Atlantic Coast)		0.20	0.23	0.00	0.00	0.43
% of grand total (Atlantic Coast)		0.03	0.04	0.00	0.00	0.07
Rio	394.9					
No. of birds		0	0	0	0	0
% of species total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00
% of species total (South America)		0.00	0.00	0.00	0.00	0.00
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00
Sao Paulo	784.5					
No. of birds		0	0	0	0	0
% of species total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00
% of species total (South America)		0.00	0.00	0.00	0.00	0.00
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.00
Rio Grande do Sul	882.9					
No. of birds		3	0	0	4	7
% of species total (Atlantic Coast)		1.43	0.00	0.00	2.53	0.02
% of species total (South America)		0.01	0.00	0.00	0.06	0.01
% of size-class total (Atlantic Coast)		0.01	0.00	0.00	0.01	0.02
% of grand total (North Coast)		0.00	0.00	0.00	0.00	0.00
All Brazil	7 852.5					
No. of birds		11 203	21 996	4	1 959	35 147
% of species total (South America)		45.04	49.57	0.01	29.65	28.97
% of size-class total (South America)		9.23	18.13	0.00	1.60	28.97
% of grand total (South America)		0.38	0.75	0.00	0.07	1.20

small numbers but a good variety of medium-sized and large species (Table 9.2*b*, 9.2*c*). The mouth of the Amazon River was notable for the very small numbers of shorebirds occurring along its shores; it would appear that the almost freshwater environment and very turbulent currents result in unsuitable habitat or feeding conditions for shorebirds.

The Northeast eco-unit, stretching from the Lencois Maranhenses National Park east of Sao Luis to Aracati, consisted mostly of sandy beaches, many with beachrock. Apart from peeps, which were found in low numbers (2600), the most numerous species were Black-bellied Plovers (1300, 5.4% of the North Coast total), Ruddy Turnstones (430, 2.1% of the North Coast total), and Sanderlings (380, 8.7% of the North Coast total), which appeared to make regular use of such habitats (Table 9.2*a*, 9.2*b*).

Despite the presence of extensive intertidal flats and mangrove coasts near Salvador and in the estuaries south of Salvador near Valenca and Itubera, shorebird totals were small (2600) in the East eco-unit. Peep totals (1500) were low, as were numbers of Ruddy Turnstones (320) and Black-bellied Plovers (170), most being found on the intertidal flats in the Baia de Todos os Santos; the majority of the 260 Sanderlings occurred on the sandy beaches north of Salvador (Table 9.2*a*, 9.2*b*). The long tropical beaches stretching south to Ilheus were almost devoid of birds.

Very few shorebirds were encountered on the coastal beaches in the Rio eco-unit, apart from occasional flocks of

Sanderlings (total 520; Table 9.2*a*). The most notable find was a large concentration of yellowlegs (4500, 5.3% of the South American total) in a flooded area between the Lagoa Feia and coastline between the Rio Paraiba do Sul and Cabo de Sao Tome.

The beaches running south from Santos towards Paranagua and associated nearshore inlets in the Sao Paulo eco-unit were notably empty of shorebirds. Many of the specimens in the University Museum in Sao Paulo were collected along these shores, and it would appear that they are used regularly by Nearctic shorebirds during migration (unpubl. results).

9.3. North coast

Sectors 1–73; Maps 9.1 (Brazil-1) to 9.6 (Brazil-6)

In terms of shorebird distribution and sedimentary structure, the coastline of northern Brazil can be divided into four distinct zones: (1) the northern coastline, from the border with French Guiana to the mouth of the Amazon system itself (North eco-unit, Sectors 1–12, Map 9.1 [Brazil-1]); (2) the mouth of the Amazon River system between the western channel (Macapa) and the Baia do Marajo (Belem) (Amazon eco-unit, Sectors 13–29, Maps 9.1 [Brazil-1] and 9.2 [Brazil-2]); (3) the coast between Belem and the Baia de Sanadi east of Sao Luis (North-central eco-unit, Sectors 30–62, Maps 9.2 [Brazil-2] and 9.3 [Brazil-3]); and (4) the remainder of the northern coastline eastwards from the Baia de Sanadi to Aracati (Northeast eco-unit, Sectors 63–73, Maps 9.4 [Brazil-4] to 9.6 [Brazil-6]).

9.3.1. Environmental conditions

The northern section of the coastline of Brazil is dominated by the Amazon River and the sediments it discharges. The Amazon River flows for over 3000 km from the Andes mountains to the Atlantic Ocean, draining an area greater than 6×10^6 km^2 (Keller 1962) and discharging an estimated 5.5×10^{12} m^3 of water per year and 4.5×10^8 tons of suspended matter (Gibbs 1967; Oltman 1968; Lisitzin 1972). Discharge is greatest during the rainy season in May and June and lowest during the dry months of October through December (Oltman 1968). Owing to the enormous outflow of fresh water, salt water is never able to penetrate into the estuary at all, and the very thorough mixing that takes place results in salinities that are only about 1 ppt at the mouth of the main river, even during periods of low discharge (Gibbs 1970*b*). The massive water outflow, prevailing winds, and high tidal range at the mouth of the estuary (up to 10 m; Gibbs 1970*a*) produce extremely turbulent conditions and violent tidal bores, which are a considerable danger to navigation. Fluctuations in river height occur as far inland as Manaus, some 800 km from the mouth of the river (Diegues 1972; Marlier 1973; Barreto *et al.* 1975). In such a high-energy environment, intertidal areas consist mostly of sandflats, and riverbanks are lined with many palms (*Euterpe oleracea* and *Mauritia flexuosa*), reflecting the freshwater regime, which effectively spans most of the mouth of the Amazon River proper and its associated islands.

Offshore, the freshwater influence extends for a considerable distance, the 35 ppt isohaline not being reached for some 185 and 230 km from the river mouth during periods of low and high discharge, respectively (Gibbs 1970*b*). The 20 ppt isohaline stretches in a broad arc offshore as far as the Amapa coastline, and farther to the coasts of French Guiana during the same respective periods (Gibbs 1970*b*).

Rivers flowing into the Baia de Marajo on the east side of the Ilha de Marajo include the Rio Para system, forming a distributary channel from the Amazon, the Rio Tocantins, and various other rivers, such as the Rio Capim. The Rio Tocantins has been estimated to have a discharge of 3.4×10^{11} m$^3 \cdot$yr^{-1} (Oltman 1968), with that of the Amazon distributary lower, the whole system probably having a lower suspended sediment load compared with the Amazon itself (Barreto *et al.* 1975). The sediments carried by the Rio Tocantins also differ, because the river drains low-standing tropical rain forest.

The mud discharged from the Amazon system forms a turbid plume, which is carried northwestwards by the North Equatorial (Guiana) Current and by longshore currents generated by the prevailing northeasterly trade winds. The North Equatorial (Guiana) Current flows with average velocities exceeding 0.5–1 m$\cdot$s^{-1} (1–2 knots) (Barreto *et al.* 1975). The longshore current is particularly strong along the coast of Amapa state to the northwest of the main channel. This current slackens during the seasonal northerly shift in wind, especially during February and March, and waters from the Para system may be carried eastwards well past the Baia de Sao Marcos, although the effect is small (Barreto *et al.* 1975). The plume of turbid water from the Amazon extends far offshore, the 5 mg$\cdot$L^{-1} line running some 100 km out from the river mouth to around 10 km out along the coast of French Guiana during high-discharge periods (Gibbs 1970*a*). The plume averages 60 km in width and extends northwestwards for some 2000 km: Amazon muds have been detected as far north as the southern Caribbean (Jacobs and Ewing 1969).

Most of the sediment discharged from the Amazon does not escape the nearshore environment, being either deposited within the estuary or transported northwestwards (Milliman *et al.* 1975*a*). Offshore muddy deposits have a somewhat different texture and composition from modern Amazon sediments and are thought to be relict structures that were deposited during an earlier period of lower sea level. Formation of a mud delta would occur if levels were some 20 m less than at present, and a level of 80–100 m lower than today would lead to most discharged material being channelled directly into the deep sea via relict channels that represent Pleistocene fluvial systems (Milliman *et al.* 1975*b*). Tidal and landward currents within the salt wedge may also act to prevent escape of sediments from the nearshore environment (Diegues 1972; Barreto *et al.* 1975).

North of the Amazon, the coastline of Amapa state is generally smooth and straight, as a result of the rapid shoreline accretion/mud deposition taking place. The very near inshore clays on the Amapa coast are almost identical with Amazon material, and it would appear unlikely that local rivers contribute much to the mudbanks on the coast; the same situation occurs in the Guianas (Eisma and van der Marel 1971). Conditions along the Amapa coastline are influenced by the extent of the freshwater plume from the Amazon River, which extends northwards during the high-discharge period, by seasonally varying longshore currents, which reach a maximum in February/March, and by the local influence of river input.

Organic contents of shelf sediments are higher north of the Amazon River than southwards, although high carbon/nitrogen ratios indicate that much of the organic material is derived from terrestrial input: the low carbonate content of sediments on the shelf reflects a fairly low level of colonization by epibenthic communities, possibly because of the bottom turbulence and sediment motion. Sediments off the Amazon mouth have considerably higher silt/clay ratios than those farther northwest along the Amapa coast, reflecting the differential transport of the lighter fraction and deposition of the heavier components. In the mouth of the river itself, the strong and turbulent currents resuspend much material, and coastal sandflats are common. Much of the infauna consists of molluscs; productivity is considered to be much less than off the eastern coast of North America (Barreto *et al.* 1975).

9.3.2. North eco-unit

Sectors 1–12; Map 9.1 (Brazil-1)

The northern part of the coastline from Cabo Cassipore to Amapa and the Ilha de Maraca is very low-lying. There are extensive mangrove forests, with *Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemosa*, and swamps, with *Montrichardia arborescens* and *Mauritia flexuosa*; some parts of the coast are backed by open palm savannahs with *Euterpe oleracea*, *Chrysobalanus icaco*, and other species. Currents appeared to be strong, particularly in the channel between the Ilha de Maraca and the mainland, and narrow sand beaches or tough mud was found along many parts of the shoreline, most of which was surveyed at high tide. The most extensive development of flats appeared to be north and south of the Calcoene and Amapa rivers (Sectors 4–5), where many birds were found on stretches of sandy-looking mud in front of the mangroves (Table 9.4). Small shorebirds, especially peeps, were numerous along these stretches of coast, the total for Sectors 3–6 (21 800) representing some 85% of the eco-unit total (Sectors 1–12) of 25 600 for this category (Table 9.3). Although these numbers were moderate compared with those in Suriname, they represented some 10% of the total small shorebirds in Brazil in this category and were the highest concentrations found in the country outside the north-central coast, with densities comparable with those in the latter area. A variety of other species was found, including Black-bellied Plovers, yellowlegs *Tringa* spp., Ruddy Turnstones, and Whimbrel, the latter two species tending to be associated with tough mud habitats. Small numbers of Red Knot occurred on sandy coastlines. Fewer birds were found on coastlines where tall mangroves came to the edge of the water (Sector 2) or where eroding coastlines occurred, such as the outer coastline of the Ilha de Maraca (Sector 9) and the coast north of the Rio Araguari (Sector 12).

9.3.3. Amazon eco-unit

Sectors 13–29; Maps 9.1 (Brazil-1) and 9.2 (Brazil-2)

The delta of the Amazon River consists of a vast low-lying complex of broad river channels, islands, mangrove forests and swamps, salt marshes with *Spartina brasiliensis*, intertidal flats, brackish and freshwater lagoons and marshes, and seasonally flooded grassland, swamp forest, and palm swamps with *Euterpe oleracea*, *Raphia taedigera*, *Manicaria saccifera*, and *Mauritia flexuosa* (Tables 9.4 and 9.6). Surveys were carried out along the shores of the North Channel (Canal do Norte; Sectors 17–19) and along the outer shores of the islands in the mouth of the Amazon system, including Ilha Bailique, Ilha Curua, Ilha Janaucu, Ilha Caviana, Ilha Mexiana, and Ilha de Marajo.

Riverbanks along the North Channel consisted mostly of tough mud. Intertidal areas occurring off the islands, on the other hand, were principally sandflats, some with *Spartina brasiliensis* colonizing their upper parts. A tidal bore was observed flooding into the mouth of the North Channel, and damaged and uprooted trees and vegetation attested to the violence of the turbulent currents along the river channels.

The eco-unit comprising the mouth of the Amazon was notable for the small numbers of shorebirds it contained, in spite of the presence of what superficially appeared to be suitable habitat. It appears likely that the instability of the sediments resulting from the very strong currents, and possibly the freshwater environment, may preclude the development of invertebrate infauna, and that lack of suitable food resources may explain the low numbers of birds.

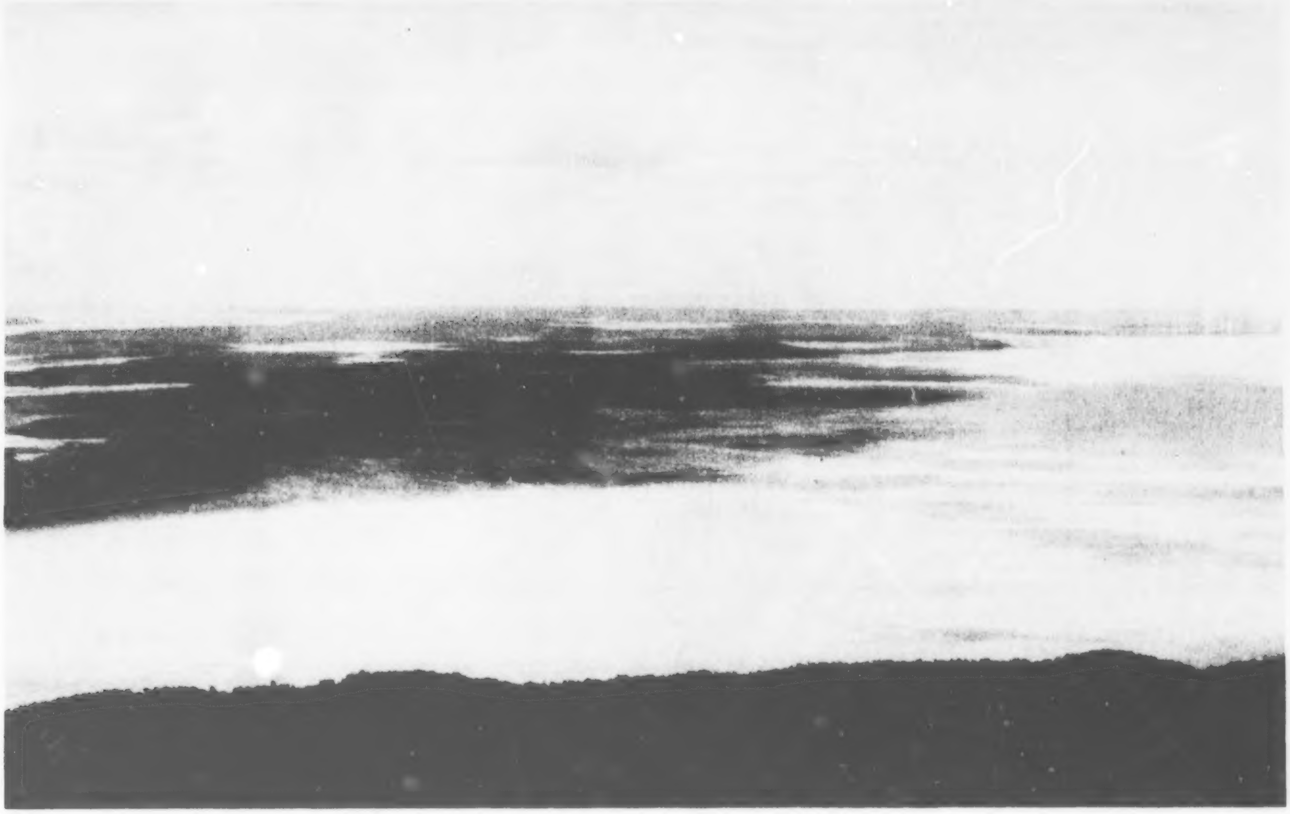
Only about 2600 shorebirds were found in the eco-unit (Tables 9.3 and 9.5), most of which (1600 or 60.4%) were in Sector 13 at the mouth of the North Channel, the remainder being spread in small numbers along the outer marshy coastlines of Ilha Janaucu and Ilha Caviana as well as along the sandy northeastern shores of Ilha de Marajo. All the Sanderlings found in the eco-unit were in the area around Ilha de Marajo.

9.4. North-central coast

9.4.1. Environmental conditions

The coastline between Belem and the Baia de Sanadi east of Sao Luis is different from the Amapa shoreline north of the Amazon, as well as from the remainder of the north coast of Brazil farther to the east. Whereas the shorelines on either side are generally fairly smooth, the section between Belem and the Sao Luis area is deeply indented, with a series of sandy headlands separating shallow bays. This coastal morphology has resulted from the invasion by the sea of former river valleys.

The most significant phenomenon affecting habitat distribution is a regular trend in sediment distribution observed in all the bay systems, involving a progressive transition from sandy outer coastlines, through mixtures of mud and sand, tough mud, and finally to soft mudflats made up of finer sediments in the inner recesses of the bays. This transition from coarse to fine sediments produces a wide variety of habitats, reflected in the impressive numbers and diversity of shorebirds using the coast (Morrison *et al.* 1985, 1986*a*, 1986*b*, 1987). The typical progression of habitats involved: (1) sandy outer coastlines backed by dunes or low cliffs; (2) sandy beaches along northeast-facing shorelines; (3) areas of sand invading tough mudbanks, characterized by stands of dead mangroves; (4) tough mudbanks and intertidal areas consisting of a mixture of sand and mud; (5) areas of new mangrove growth, often fronted by marsh development and muddy patches; and (6) progressively finer, softer mudflats backed by mangrove forests (Morrison *et al.* 1987). The mangrove forests are often very extensive, not merely forming a layer bordering the shore, but in some cases extending completely across the bases of the headlands from one bay to the next and running great distances inland, indicating an enormous zone of tidal flooding around the bay. The mangrove forests were the most impressive seen in Brazil and represent one of the best examples of this habitat in South America.



North-central coast of Brazil. The indented coastline of north-central Brazil between Sao Luis and Belem consists of wide bays containing a variety of habitat types, ranging from sandflats to soft mudflats backed by some of the most extensive stands of mangrove forest in South America. The area is of great importance to a wide range of Nearctic shorebirds.

The area under consideration lies geologically within the Sao Luis Basin, a small coastal basin situated on the northern part of the larger Maranhao, or Parnaiba, Basin. The Sao Luis Basin contains some 4000 m of sediments that are apparently younger than the Paleozoic and Mesozoic sediments of the Parnaiba Basin (Putzer 1968; Asmus and Ponte 1973; Bigarella 1973; Barreto *et al.* 1975), and outcroppings of Precambrian basement rocks also occur. The climate is much wetter than that of areas farther east, affecting the weathering and amount and characteristics of sediments discharged at the coast.

The entire nearshore platform is dominated by sandy sediments (Barreto *et al.* 1975), and the outer headlands and shores are fronted by sandy beaches. Many of the bays contain extensive sandy shoals, some of which have grown into low sandy islands. The coastal rivers carry sediments derived from late Mesozoic and Tertiary sedimentary strata, and because these have been exposed to extensive weathering typical of tropical rain forests, the grains are more mature or rounded than the material discharged from the Amazon (Barreto *et al.* 1975). Offshore sediments show a distinctive mineral composition, reflecting the source material, weathering, and transport histories of material on this section of coast, and are indicative of rain-forest sediments (Barreto *et al.* 1975). Most of the finer sediment brought down by the rivers does not appear to escape from the bays and is found deposited as mudbanks along the inner margins or recesses of the bays. Coastal waters are generally not turbid and carry little sediment load. Shelf sediments are very poor in organic matter, although increased carbon/nitrogen ratios around the outflow of the Para and Gurupi rivers and in the Baia de Sao Marcos reflect input from terrigenous sources. With most material apparently remaining within the bay systems, such areas are likely to develop the most productive shorelines. The major rivers, such as the Gurupi, Mearim, and Itapecuru, flow throughout the year (Barreto *et al.* 1975), although this may not be the case with the smaller rivers entering some of the bays.

Offshore, the North Equatorial (Guiana) Current flows northwestwards, probably moving bottom sandy sediments with it (Barreto *et al.* 1975). The wind-driven longshore current generally flows in the same direction, although a countercurrent carrying sediments from Baia de Marajo eastwards appears to develop in February and March. Tidal currents can be particularly strong, especially around areas off the mouths of Baia de Marajo and Baia de Sao Marcos (Barreto *et al.* 1975). Tidal ranges are considerable (approximately 5–8 m; Marinha do Brasil 1985; Scott and Carbonell 1986).

9.4.2. North-central eco-unit

Sectors 30–62; Maps 9.3 (Brazil-3) and 9.4 (Brazil-4)

9.4.2.1. Habitats

Nearly all the bays on the north-central coast of Brazil show the typical progression of habitats described above, with muddy inner areas and sandy outer coastlines (Tables 9.8 and 9.10). In the Baia de Sao Marcos (Sectors 54–58), for instance, such a pattern occurred on both the west and east coasts. On the west coast (Sector 54), extensive intertidal

Map 9.1 (Brazil-1)
Distribution of Nearctic shorebirds on the northern coast of Brazil

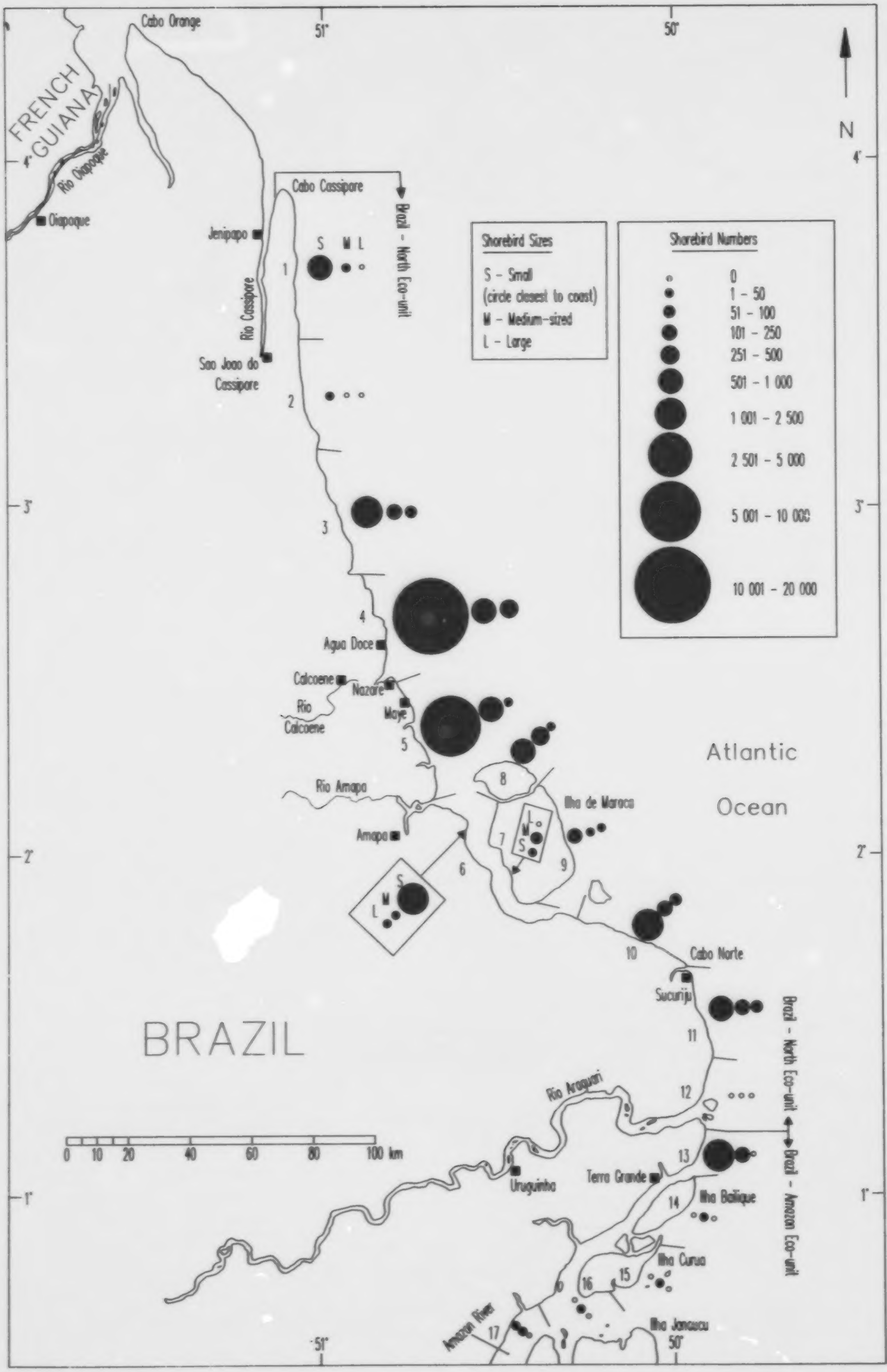

Cabo Orange
51°
50°
N
4°
3°
2°
1°
FRENCH GUIANA
Rio Oiapoque
Oiapoque
Cabo Cassipore
Brazil - North Eco-unit
Jenipapo
S M L
Rio Cassipore
Sao Joao do Cassipore
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Agua Doce
Calcoene
Nazare
Rio Calcoene
Moye
Rio Amapa
Amapa
Ilha de Maraca
Atlantic Ocean
Cabo Norte
Sucuriju
BRAZIL
Rio Araguari
0 10 20 40 60 80 100 km
Uruguinho
Terra Grande
Brazil - North Eco-unit
Brazil - Amazon Eco-unit
Ilha Bailique
Ilha Curua
Amazon River
Ilha Janaucu

Table 9.3
Totals of Nearctic shorebirds in survey sectors in Map 9.1 (Brazil-1)

Sector no.	Sector length (km)	Semi-palmated Plover	Spotted Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Lesser-Golden-Plover	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Red Knot	Dowit-cher species	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Total shore-birds
1	57.2	0	0	0	812	812	0	0	0	0	0	0	20	20	0	0	0	0	832
2	36.5	0	0	2	34	36	0	0	0	0	0	0	0	0	0	0	0	0	36
3	40.0	0	0	0	2 200	2 200	47	70	0	0	100	0	1	218	50	0	20	70	2 488
4	36.7	0	0	0	10 966	10 966	0	229	0	72	20	0	360	681	0	25	352	377	12 024
5	42.8	0	0	0	6 345	6 345	0	265	0	25	0	0	400	690	0	0	50	50	7 085
6	52.7	0	0	0	2 240	2 240	0	3	0	0	0	0	4	7	2	0	20	22	2 269
7	33.2	0	0	0	17	17	0	0	0	35	0	20	0	55	0	0	0	0	72
8	37.6	0	0	0	546	546	0	57	70	0	0	0	183	310	44	0	2	46	902
9	34.2	0	0	0	240	240	0	5	0	0	0	0	0	5	1	0	2	3	248
10	44.6	0	2	0	1 690	1 692	0	8	80	44	0	0	40	172	40	0	40	80	1 944
11	24.5	0	0	0	504	504	0	39	41	29	0	0	56	165	1	0	25	26	695
12	24.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	23.1	470	0	0	890	1 360	0	101	0	34	0	0	93	228	0	0	0	0	1 588
14	22.6	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1
15	17.4	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
16	21.6	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1
17	38.3	0	1	0	0	1	0	0	0	3	0	0	0	3	0	0	0	0	4
Total	587.3	470	3	2	26 484	26 959	47	777	192	244	120	20	1 157	2 557	138	25	511	674	30 190

Table 9.4
Principal habitats in survey sectors in Map 9.1 (Brazil-1)

Sector no.	Habitat description
1	Some sand beach and tough mudbanks, mangroves / forest, marsh
2	Sand and mud shore, mangroves / forest, lagoons, open scrub
3	Sand and tough mud beach, mangroves / forest, scrub, wetlands
4	Sand beach, narrow mudbanks, mangroves / forest
5	Sandy mud beach, some mudflats, mangroves / forest, lagoons
6	Tough mud shore, some mudflats, mangroves / lagoons, forest
7	Steep narrow mud shore / grassland, open forest
8	Tough mudflats, mangroves (some dead) / marsh, forest
9	Narrow tough mudbanks, mangroves / forest
10	Narrow tough mudbanks, mangroves / forest
11	Sandy foreshore and mudflats, salt marsh / scrub
12	Tough mud, some sand beach, mangroves (stumps) / forest, marsh
13	Brackish estuary; broad sandflats, salt marsh, some mangroves / forest, marsh
14	Brackish estuary; broad mud- and sandflats, mangroves / forest / marsh
15	Brackish estuary; broad mud- and sandflats, mangroves / forest / marsh
16	Brackish estuary; broad mud- and sandflats, marsh, mangroves (many logs) / forest
17	Brackish estuary; broad sandflats and bars, mangroves / forest

areas are found, becoming progressively sandier towards the mouth of the bay. The outer coastline north of Alcantara towards the Baia do Cuma consists of sandy beaches backed by low, eroding cliffs. Soft mudflats occur in the inner parts of the bay and also in sheltered areas where creeks or rivers enter the bay, e.g., near Alcantara and in the channel on the southwest side of the Ilha dos Caranguejos (between it and the Ilha Verde; Sector 55). On the east side of the bay, soft flats are found in shallow embayments along the main channel of the Rio Mearim below the Ilha dos Caranguejos (Sector 57). Fierce currents occur along the channel between the Ilha dos Caranguejos and the mainland, producing a considerable tidal rip near the island. Much of the east coast of the island (Sector 56) consisted of relatively narrow, tough-looking eroded mudbanks, with many mangroves uprooted by the currents. Heavily eroded sections, with distinctive stepped terraces near the channel, also occurred on the mainland side (Sector 57), although flats were generally better developed. The coarsening trend in sediments towards the sea continued, with quite tough-looking intertidal flats south of Sao Luis (Sector 58) and sandier areas north of the city (Sector 59).

A broadly similar pattern occurs in the Baia de Sao Jose. The inner part, comprising the Baia do Arraial, contains well-developed mudflats lined with mangrove forests; large flats also develop around the mouths of rivers entering the bay. The west coast of the bay becomes increasingly sandy towards the sea: extensive sandy mudflats occur below sandy beaches and palm-covered hills below Ribamar, and a succession of sandflats and beaches occurs north of Ribamar. The east side of the bay is lined with mangroves. Sediments become increasingly coarser towards the outer part of the bay, with areas of dying mangroves appearing where sand has invaded muddier substrates. Offshore, extensive sandbars have developed, and large areas of sandflats are exposed at low tide. Mangrove forests cover much of the island between the Baia de Sao Jose and Baia do Tubarao. Habitat patterns are similar in the Baia do Tubarao and Baia de Sanadi.

9.4.2.2. Shorebirds

Nearly 327 000 Nearctic shorebirds were counted in the North-central eco-unit between Belem and the Baia de Sanadi, the total consisting of some 196 000 small shorebirds (59.8%), 97 000 medium-sized shorebirds (29.7%), and 34 000 large shorebirds (10.4%) (Tables 9.7 and 9.9). The small, medium-sized, and large size-class totals represented 9.4, 29.0, and 56.3% of the respective totals for the North Coast of South America, and 8.4, 21.3, and 28.1% of the respective continental totals, demonstrating that the coastline is of major international importance for shorebirds.

The most significant concentrations overall were found on the coastline north and west of the Baia de Sao Marcos between the Ilha Lencois and Baia do Cuma (Sec-

Map 9.2 (Brazil-2)
Distribution of Nearctic shorebirds along the Amazon delta coast of Brazil

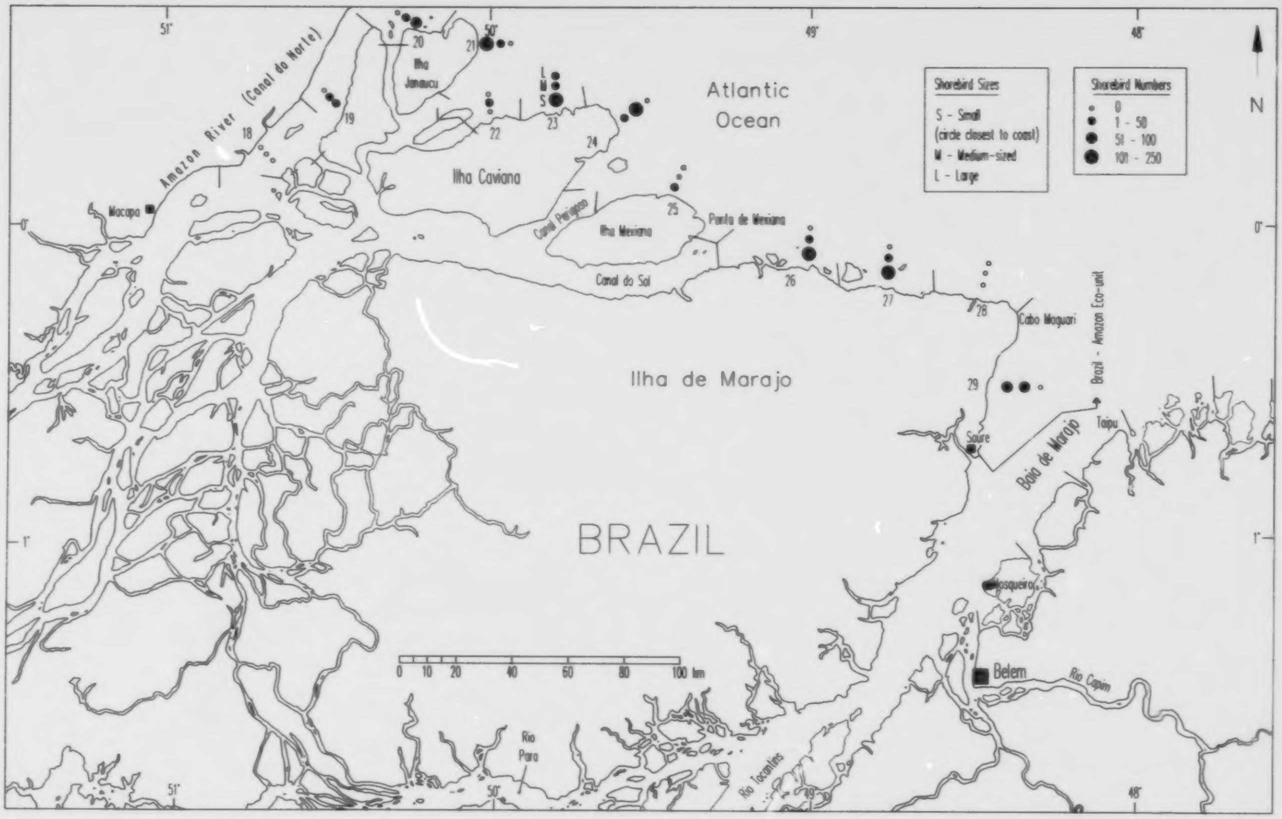

51°
50°
49°
48°
0°
1°
Atlantic Ocean
N
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
18
19
20
21
22
23
24
25
26
27
28
29
L
M
S
Ilha Janaucu
Amazon River (Canal do Norte)
Macapa
Ilha Caviana
Canal Perigoso
Ilha Mexiana
Ponta de Mexiana
Canal do Sol
Cabo Maguari
Brazil - Amazon Eco-unit
Ilha de Marajo
Taipu
Soure
Baia de Marajo
BRAZIL
Mosqueiro
Belem
Rio Capim
0 10 20 40 60 80 100 km
Rio Para
Rio Tocantins

Table 9.5
Totals of Nearctic shorebirds in survey sectors in Map 9.2 (Brazil-2)

Sector no.	Sector length (km)	Spotted Sandpiper	Sanderling	Small shorebird species	Total small shorebirds	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Medium-sized shorebird species	Total medium-sized shorebirds	Large shorebird species	Total large shorebirds	Total shorebirds
18	36.8	0	0	0	0	0	0	0	0	0	0	0	0
19	44.9	2	0	0	2	0	4	0	0	4	0	0	6
20	27.2	0	0	55	55	1	18	0	0	19	0	0	74
21	40.8	0	0	120	120	2	3	0	0	5	0	0	125
22	30.8	0	0	0	0	0	1	0	0	1	0	0	1
23	45.8	1	0	128	129	0	13	0	21	34	2	2	165
24	62.6	0	0	30	30	0	1	150	0	151	0	0	181
25	51.7	0	0	5	5	0	0	0	0	0	0	0	5
26	50.3	0	10	161	171	0	9	0	0	9	0	0	180
27	29.8	0	7	100	107	0	4	0	0	4	0	0	111
28	35.2	0	0	0	0	0	0	0	0	0	0	0	0
29	54.9	0	100	0	100	0	60	0	25	85	0	0	185
Total	510.8	3	117	599	719	3	113	150	46	312	2	2	1 033

Table 9.6
Principal habitats in survey sectors in Map 9.2 (Brazil-2)

Sector no.	Habitat description
18	Brackish estuary; broad sandflats and bars, mangroves (many dead) / scrub, wetlands, forest
19	Brackish estuary; broad sand- and mudflats, marsh, some mangroves (often dead) / scrub, wetland, forest
20	Brackish estuary; broad sandflats, some tough mudflats, few mangroves / forest, scrub
21	Brackish estuary; broad sand beach, marsh, some mangroves / forest
22	Brackish estuary; tough mudbanks, marsh, mostly dead mangroves / forest
23	Brackish estuary; tough mudbanks, marsh / scrubby forest, wetlands
24	Brackish estuary; some sand beach, marsh / scrubby forest, wetlands
25	Brackish estuary; tough mudbanks with mangrove debris, some sand beach / scrubby forest
26	Brackish estuary; sand beach / palms, mangroves, dunes / forest
27	Brackish estuary; sand beach, some mudbanks / some dunes, palms / scrubby forest
28	Brackish estuary; sand beach, some muddy sections / dunes / palms, scrubby forest
29	Brackish estuary; broad sandflats, some marsh / extensive flooded fields, scrubby forest

tors 48–52), with the highest sector total (Sector 50, 56 000; Table 9.9) occurring around the Baia Cabelo da Velha northeast of Cururupu. Important concentrations were also found around the Baia de Sao Marcos, especially around the inner channel of the Rio Mearim (Sector 57) and on the west coast of the bay (Sector 54). Further significant concentrations were found on the bays to the west and especially the east of the Rio Gurupi (Sectors 42–45). Moderate concentrations occurred in the western sectors towards Salinopolis (Sectors 36–38).

Distribution patterns of the different size categories or of individual species of shorebirds, while by no means identical, did show a number of general similarities, with particular sections of the coastline being favoured by a wide range of species (Morrison *et al.* 1986*a*, 1986*b*).

The majority of the 192 000 unidentified small shorebirds (peeps) consisted of Semipalmated Sandpipers *Calidris pusilla* (Tables 9.7 and 9.9). Moderate numbers were found in the bays to the east of Sao Luis, including the Baia de Sanadi (Sector 62), Baia de Tubarao (Sector 61), and Baia do Arraial/Baia de Sao Jose (Sector 60). Larger numbers were encountered on the soft flats on the lower part of the Rio Mearim (Sector 57), in the channel between the Ilha Verde and Ilha dos Caranguejos (Sector 55), and on the west side of the Baia de Sao Marcos (Sector 54). The largest concentrations of peeps were found in the bays to the north and west of the Baia de Sao Marcos, between the Baia do Cuma and the Baia Cabelo da Velha (Sectors 48–52). Large concentrations were also found in the bays around and to the east of the mouth of the Rio Gurupi (Sectors 42–45), and moderate concentrations were found in the western sectors up to Salinopolis (Sector 37).

The north-central coast of Brazil was regionally important for Sanderlings, holding 3100, or 70.5%, of the North Coast total. Most Sanderlings occurred on the outer coasts and beaches around Sao Luis (Sector 59) and on the coastline to the north and west of the Baia de Sao Marcos (Sectors 48 and 50–54); few were encountered on the central or western sectors of the coast (Tables 9.7 and 9.9).

The overall distribution of the 97 000 medium-sized shorebirds showed a clumped pattern, with significant concentrations on the northwest corner of Sao Luis Island (Ilha do Curupu; Sector 59), on the west side of the Baia de Sao Marcos (Sector 54), in the bays between Baia do Cuma and Ilha Lencois (Sectors 48–52), in the bays around the mouth and to the east of the Rio Gurupi (Sectors 42–45), and in the bays around and east of Salinopolis (Sectors 37–38). Distributions of individual species, however, varied considerably.

The north-central coast of Brazil was the most important area in South America for Black-bellied Plovers, the total of 14 700 representing 54.0 and 61.9% of the continental and North Coast totals, respectively (Tables 9.7 and 9.9). Black-bellied Plovers were common on the mainland shore of the Rio Mearim (Sector 57), on the west side of the Baia de Sao Marcos (Sector 54), around the Baia Cabelo da Velha (Sectors 50 and 51), and in the bays east of the mouth of the Rio Gurupi (Sectors 43 and 44); relatively few birds were seen in the western sectors of the coast.

The north-central coast of Brazil was also the most important wintering area discovered in South America for Ruddy Turnstones, the total of 17 900 representing 76.2 and 88.5% of the continental and North Coast totals, respectively (Tables 9.7 and 9.9). Ruddy Turnstones were fairly evenly spread along the coastline, being particularly common in areas with tough mudbanks; highest numbers occurred around the Rio Gurupi (Sectors 42–45).

Dowitchers were fairly evenly distributed along the north coast of South America, with north-central Brazil (total 8100, representing 16.6 and 17.1% of the continental and North Coast totals, respectively) second in importance after Suriname (Tables 9.7 and 9.9). Dowitchers were concentrated around the Baia dos Lencois (Sectors 46–51), with smaller numbers around the Rio Gurupi (Sectors 42–44) and scattered concentrations near Salinopolis (Sectors 33 and 36).

The flocks of Red Knot tentatively identified in Sectors 51 and 59 represent the only major concentrations discovered on the surveys outside the main wintering grounds in Patagonia and Tierra del Fuego (Table 9.9).

Yellowlegs were scattered in very low numbers along the north-central coast of Brazil, most being found east of the Rio Gurupi (Sector 44). Distribution of yellowlegs on the north coast of the continent was clearly centred on the Guianas, with by far the largest numbers in Suriname; the north-central coast of Brazil was of less relative importance for the two species involved.

Large shorebirds (total 34 000) showed a general pattern of distribution similar to those of the other size categories, largest numbers being recorded around the Baia dos Lencois and Baia do Capim (Sectors 48–51), the west side of Baia de Sao Marcos (Sector 54), the Rio Gurupi (Sectors 41–45), and towards Salinopolis (Sector 38).

The north-central coast of Brazil was the most important wintering area discovered on the coast of South America for Whimbrels (total 10 900, representing 43.7 and 71.3% of continental and North Coast totals, respectively) and for Willets (total 21 900, representing 49.3 and 55.2% of continental and North Coast totals, respectively) (Tables 9.7 and 9.9). Willets were found principally on the coast northwest of the Baia de Sao Marcos (Sectors 49–52), whereas Whimbrels were more evenly distributed.

In summary, the surveys clearly demonstrated that the north-central coast of Brazil is of major international importance as a wintering area for shorebirds and is of critical importance for several individual species.

Map 9.3 (Brazil-3)
Distribution of Nearctic shorebirds along the Belem coast of Brazil

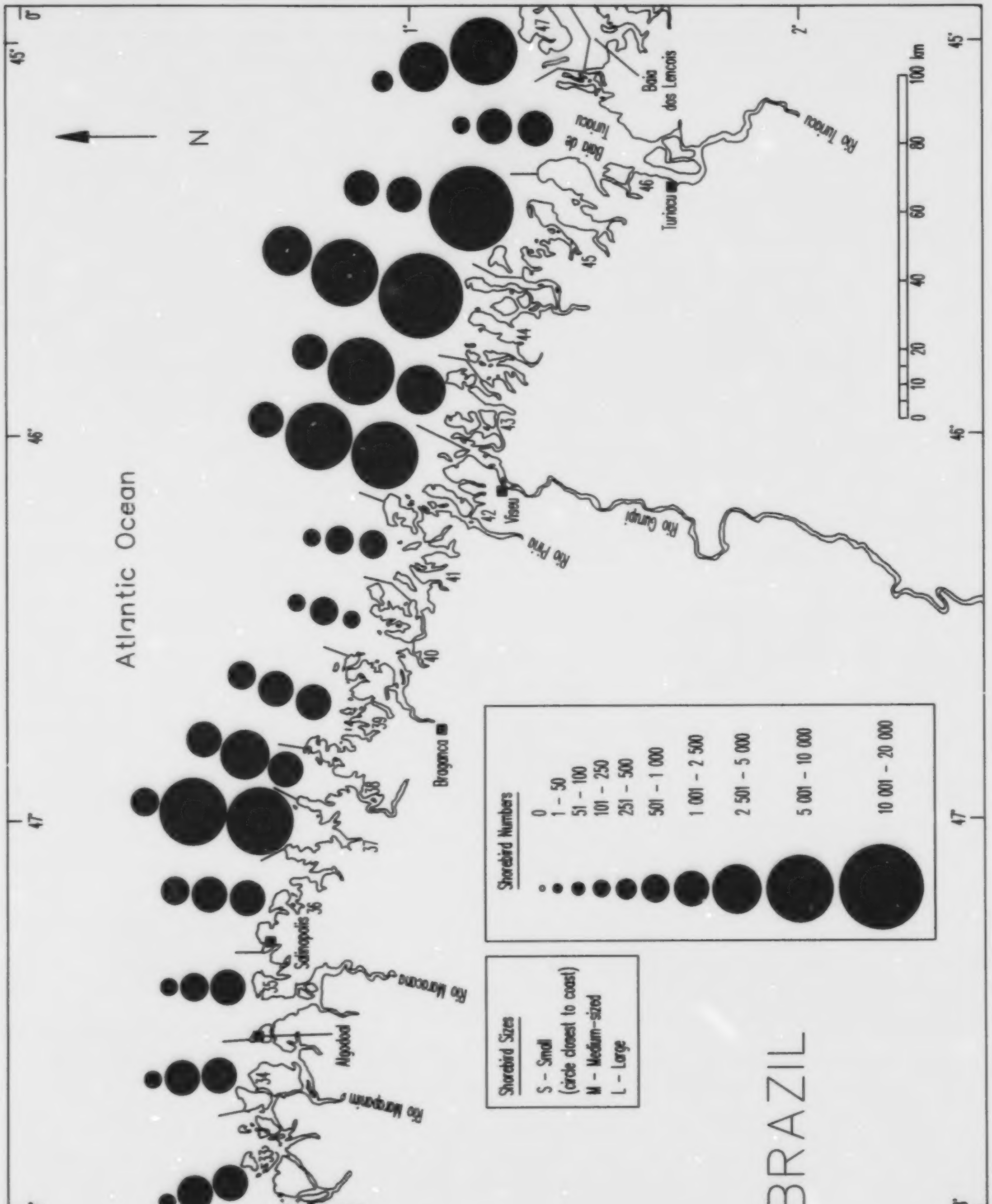

Atlantic Ocean
BRAZIL
N
Ilha de Marajo
Baia de Marajo
Brazil - North-central Eco-unit
Belem
Mosqueiro
Colares
Taipu
Rio Marapanim
Algodoal
Rio Maracana
Salinopolis
Braganca
Rio Piria
Viseu
Rio Gurupi
Turiacu
Baia de Turiacu
Rio Turiacu
Baia dos Lencois
Rio Tocantins
S
M
L
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
0°
1°
2°
45°
46°
47°
48°
0
10
20
40
60
80
100 km
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large

Table 9.7
Totals of Nearctic shorebirds in survey sectors in Map 9.3 (Brazil-3)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Red Knot	Dowitcher species	Uniden-tified medium-sized shorebird species	Total medium-sized shore-birds	Whimbrel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Total shore-birds
30	39.9	5	0	0	5	0	130	0	0	20	0	150	0	0	0	0	155
31	39.1	2	0	47	49	6	10	29	0	0	6	51	0	0	0	0	100
32	33.9	0	0	220	220	8	144	14	0	0	151	317	21	43	0	64	601
33	81.1	35	0	995	1 030	71	298	23	0	335	883	1 610	74	76	0	150	2 790
34	74.0	94	0	1 633	1 727	44	705	11	0	40	378	1 178	78	62	0	140	3 045
35	76.4	2	60	1 605	1 667	134	335	6	0	2	467	944	70	108	0	178	2 789
36	90.1	1	0	1 187	1 188	401	314	25	0	350	1 266	2 356	364	385	0	749	4 293
37	46.5	5	0	5 332	5 337	465	290	0	0	20	4 885	5 660	381	447	0	828	11 825
38	40.0	6	0	1 650	1 656	468	1 228	0	40	0	844	2 580	745	663	410	1 818	6 054
39	55.1	0	5	1 062	1 067	786	654	2	0	0	321	1 763	440	201	10	651	3 481
40	99.8	0	0	240	240	115	323	36	0	0	82	556	115	68	0	183	979
41	70.1	0	0	740	740	93	136	64	0	20	548	861	119	123	0	242	1 843
42	64.0	0	0	8 480	8 480	393	1 348	16	0	300	5 581	7 638	914	622	442	1 978	18 096
43	92.7	2	27	4 697	4 726	1 684	2 179	4	0	150	3 015	7 032	669	396	0	1 065	12 823
44	137.7	2	0	19 659	19 661	1 531	1 098	349	0	400	4 127	7 505	1 301	1 899	200	3 400	30 566
45	123.8	4	1	10 050	10 055	142	1 289	20	0	82	925	2 458	523	503	0	1 026	13 539
46	104.3	1	44	2 100	2 145	92	138	5	1	1 107	143	1 486	82	131	0	213	3 844
47	65.6	0	0	9 600	9 600	187	51	13	0	3 000	428	3 679	40	352	0	392	13 671
Total	1 334.1	159	137	69 297	69 593	6 620	10 670	617	41	5 826	24 050	47 824	5 936	6 079	1 062	13 077	130 494

Table 9.8
Principal habitats in survey sectors in Map 9.3 (Brazil-3)

Sector no.	Habitat description
30	Brackish estuary; sandy beaches and flats, rocky outcrops / some mangroves / tropical forest
31	Brackish estuary; sandflats, marshes / mangroves
32	Brackish estuary; mudflats, marshes / mangroves
33	Bay systems; sandflats, some mudflats, mangroves, tough banks, marsh; rocky outcrops, sand beaches, points / dunes, river channel, forest
34	Bay systems; sandflats, some mudflats, mangroves, tough banks, marsh; rocky outcrops, sand beaches, points / dunes, river channel, forest
35	Bay systems; sandflats, some mudflats, mangroves, tough banks, marsh; rocky outcrops, sand beaches, points / dunes, river channel, forest
36	Bay systems; sandflats, some mudflats, mangroves, tough banks, marsh; rocky outcrops, sand beaches, points / dunes, river channel, forest
37	Bay systems; sandflats, mudflats, mangroves, marsh; sandy headlands, beaches, and points / forest, dunes
38	Bay systems; sandflats, mudflats, mangroves, marsh; sandy headlands, beaches, and points / forest, dunes
39	Bay systems; sandflats, mudflats, mangroves, marsh; sandy headlands, beaches, and points / forest, dunes
40	Bay systems; sandflats, mudflats, mangroves, marsh; sandy headlands, beaches, and points / forest, dunes
41	Bay systems; sandflats, mudflats, mangroves, marsh; sandy headlands, beaches, and points / forest, dunes
42	Bay systems; mud- and sandflats, mangroves, marsh; headlands with sand beaches and points / forest, dunes
43	Bay systems; mud- and sandflats, mangroves, marsh; headlands with sand beaches and points / forest, dunes
44	Bay systems; mud- and sandflats, mangroves, marsh; headlands with sand beaches and points / forest, dunes
45	Bay systems; mud- and sandflats, mangroves, marsh; headlands with sand beaches and points / forest, dunes
46	Bay systems; major river channel, mud- and sandflats, marsh, sand beaches, tough mudbanks, mangroves / forest
47	Broad sand beaches, small muddy inlets with mangroves / forest, dunes

9.5. North coast: Sao Luis to Salvador

9.5.1. Environmental conditions

Much of the north coast of Brazil between Sao Luis and Natal is relatively low-lying, particularly between Sao Luis and Parnaiba, where relief is generally less than 100 m. Between Parnaiba and Fortaleza, the mountains of the Serra de Ibiapaba outcrop near the coast, rising to elevations exceeding 500 m. Farther east, the coastal plain widens again to more than 50 km between Fortaleza and Natal; inland, the mountains of the Precambrian Brazilian Coastal (Atlantic) Shield stretch southwards along the east coast of Brazil, reaching elevations of 500–1000 m.

The mountains exert a considerable influence on the climate. On the east coast, prevailing easterly or southeasterly winds deposit their moisture on the coastal ranges, where rainfall may exceed 1500 $mm \cdot yr^{-1}$ (Andrade 1964). To the west is found a "drought polygon," where conditions are arid to semiarid, with precipitation around 750 $mm \cdot yr^{-1}$ and in some places less than 500 $mm \cdot yr^{-1}$ (e.g., Ceara state, where it has recently averaged less than 100 $mm \cdot yr^{-1}$) (Barreto *et al.* 1975; Summerhayes *et al.* 1975). This dry area reaches the coast between the Rio Parnaiba and Touros. Farther west towards Sao Luis, rainfall is generally higher and can reach 1000 $mm \cdot yr^{-1}$. The climate is tropical, with temperatures ranging between 26 and 30°C throughout the year.

The two major drainage basins are those of the Parnaiba and Jaguaribe rivers. The Rio Parnaiba drains an area of about 300 000 km^2, involving the geological Parnaiba (Maranhao) Basin. The Rio Jaguaribe is about 450 km long and drains an area of some 80 000 km^2 (Milliman 1975; Summerhayes *et al.* 1975). Although the Rio Parnaiba flows year-round, the smaller rivers in the arid northeast dry up; the Rio Acarau, for instance, drains the Serra de Ibiapaba only during the rainy months (Barreto *et al.* 1975). In the northeast, rivers such as the Jaguaribe and the Acu drain part of the Precambrian Coastal Brazilian (Atlantic) Shield, which contains distinctive studded acid plutonic intrusive rocks (Summerhayes *et al.* 1975).

Map 9.4 (Brazil-4)
Distribution of Nearctic shorebirds along the Sao Luis coast of Brazil

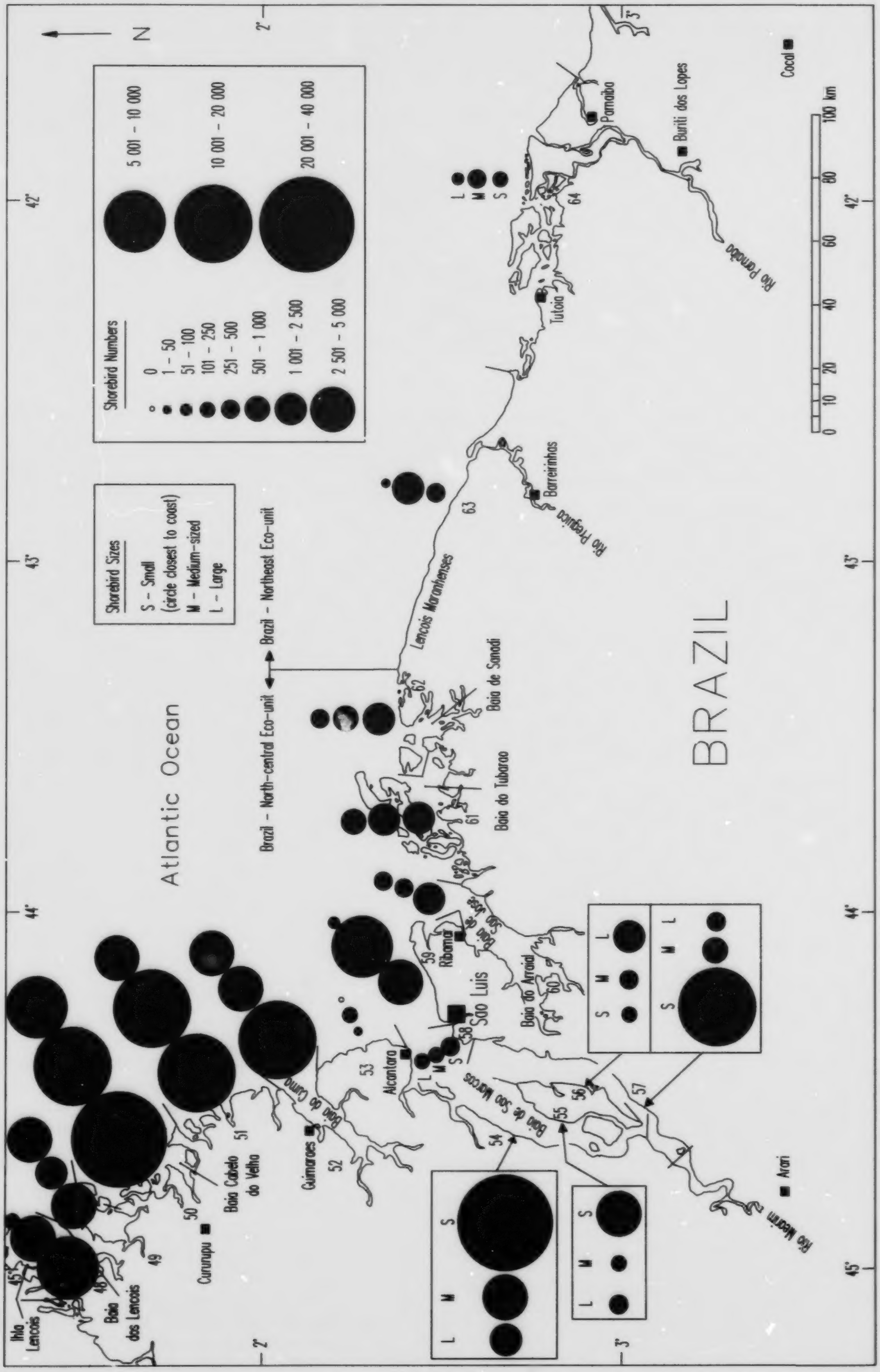

N
Atlantic Ocean
BRAZIL
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Brazil - North-central Eco-unit
Brazil - Northeast Eco-unit
Ilha Lencois
Baia dos Lencois
Cururupu
Baia Cabelo do Velha
Guimaraes
Baia do Cuma
Alcantara
Baia de Sao Marcos
Sao Luis
Ribamar
Baia de Sao Jose
Baia do Arraial
Baia do Tubarao
Baia de Sanadi
Lencois Maranhenses
Barreirinhas
Rio Preguica
Tutoia
Parnaiba
Buriti dos Lopes
Cocal
Rio Parnaiba
Arari
Rio Mearim
S
M
L
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
2°
3°
42°
43°
44°
45°
0
10
20
40
60
80
100 km

Table 9.9
Totals of Nearctic shorebirds in survey sectors in Map 9.4 (Brazil-4)

Sector no.	Sector length (km)	Spotted Sandpiper	Solitary Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Red Knot	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
48	60.2	0	0	150	5 088	5 238	0	909	611	15	0	943	68	2 546	77	53	0	0	130	7 914
49	64.1	0	0	0	2 740	2 740	0	251	451	11	0	260	400	1 373	1 190	2 856	1	20	4 067	8 180
50	100.8	0	0	170	36 734	36 904	0	2 583	679	14	0	190	10 158	13 624	666	4 858	0	0	5 524	56 052
51	76.4	0	0	373	10 644	11 017	0	1 073	1 538	22	5 000	600	6 166	14 399	736	1 981	2	0	2 719	28 135
52	101.6	0	0	372	13 690	14 062	0	238	1 031	7	0	3	3 171	4 450	480	2 572	0	300	3 352	21 864
53	37.2	0	0	42	6	48	0	218	2	0	0	0	22	242	0	0	0	0	0	290
54	85.4	21	0	80	25 690	25 791	0	1 858	914	0	150	95	618	3 635	960	1 211	0	0	2 171	31 597
55	53.3	29	0	0	4 340	4 369	0	25	58	0	0	63	93	239	158	143	0	0	301	4 909
56	46.0	1	0	0	235	236	0	67	424	3	0	0	0	494	237	773	0	0	1 010	1 740
57	102.1	35	0	0	14 830	14 865	0	543	261	0	0	0	45	849	[illegible]	265	0	0	417	16 131
58	18.6	0	0	5	250	255	0	5	40	0	0	0	90	135	[illegible]	142	0	0	149	539
59	69.0	0	0	1 713	3 156	4 869	0	50	697	0	3 000	0	1 458	5 205	7	58	1	0	66	10 140
60	115.3	0	0	0	1 490	1 490	0	98	73	6	0	0	157	334	46	229	0	0	275	2 099
61	155.4	1	0	15	1 620	1 636	0	116	196	30	0	95	592	1 029	100	402	0	0	502	3 167
62	85.2	0	1	23	2 394	2 418	0	57	264	78	0	30	420	849	127	246	0	0	373	3 640
63	125.0	1	0	229	35	265	82	500	188	52	0	33	422	1 277	9	3	0	0	12	1 554
64	449.4	0	0	38	164	202	0	241	15	51	0	0	100	407	57	21	0	0	78	687
Total	1 745.0	88	[illegible]	3 210	123 106	126 405	82	8 832	7 442	289	8 150	2 312	23 980	51 087	5 009	15 813	4	320	21 146	198 638

Table 9.10
Principal habitats in survey sectors in Map 9.4 (Brazil-4)

Sector no.	Habitat description
48	Shallow bay with extensive mud- and sandflats, mangroves, marsh / forest with muddy pans
49	Bay with mud- and sandflats, mangroves, some sand beaches / forest
50	Bays with mudflats, mangroves; ocean coast with sand beaches and points / forest with muddy pans, dunes
51	Sand beaches, inlets with mudflats, mangroves / forest, dunes
52	Bay with mudflats, marsh, mangroves / forest, river exits
53	Sand beaches / cliffs / forest
54	Bay system; firm mudflats, sandflats, mangroves, marsh, sandbars / forest, river channels
55	Bay system; sandflats, mudflats, mangroves / forest, open grassy areas, creek channels
56	Major river channel with tough eroded mudbanks, mangroves / forest
57	Major river channel with tough eroded mudbanks, some soft mudflats, mangroves / forest, open grassy areas
58	Firm mudflats backed by mangroves / forested hills, industrial terminal
59	Sand beaches, points, some muddy inlets with mangroves / dunes, towns
60	Bay system; mudflats, sandflats, marsh, mangroves, river exits; outer sand beaches / forest, dunes, river channels
61	Bay system; mudflats, sandflats, marsh, mangroves, river exits; outer sand beaches / forest, dunes, river channels
62	Bay system; mudflats, sandflats, marsh, river exits, outer sand beaches / forest, dunes, river channels
63	Narrow sand beach, some tough mud sections / dunes, scrubby desert
64	Narrow sand beach with some broad mudflats and mangroves around islands and rivers / dunes in places / scrubby desert

Such factors are important in determining the amount and type of sediment reaching the coast.

The area between Sao Luis and Parnaiba lies within the Barreirinhas Basin, a coastal subbasin separated from the major Parnaiba (Maranhao) Basin by the Ferrer Arch (Mesner and Wooldridge 1964; Bigarella 1973; Asmus and Ponte 1973). This basin occupies a narrow belt 20–80 km wide and 300 km long, with an onshore area of some 13 000 km². The basin itself contains 10 000 m or more of sediments, mostly Cretaceous, and has good oil potential (Mesner and Wooldridge 1964).

The eastern part of the north coast from Aracati to around Natal lies on the Potiguar Basin, containing some 1500 m of Cretaceous and Tertiary sediments and covering an area of about 25 000 km² on its onshore portion; it is limited to both south and west by basement Precambrian crystalline rocks (Asmus and Ponte 1973).

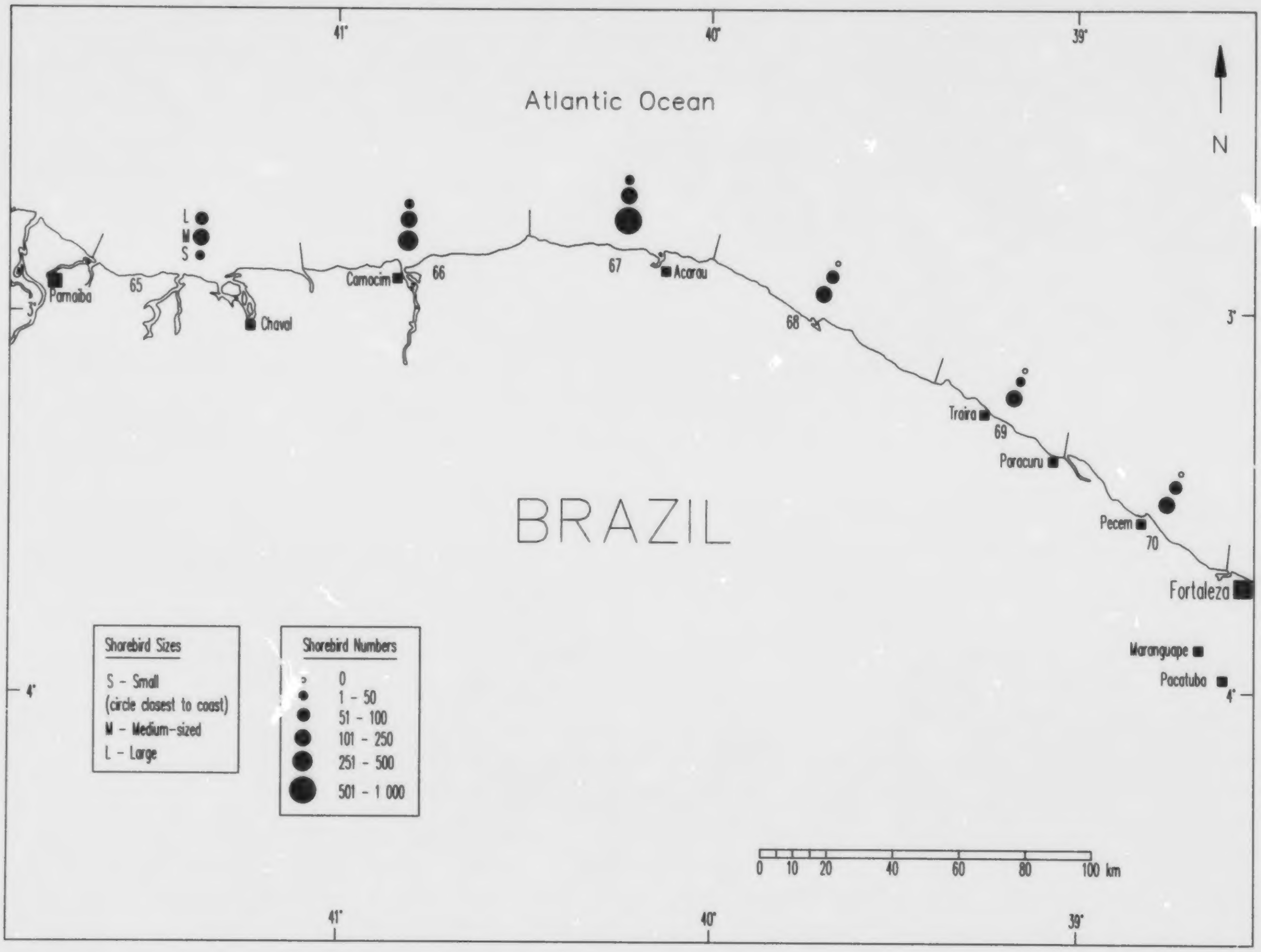
Offshore, the oceanic circulation is dominated by the North Brazilian Coastal Current, which flows north and west along the coast at 0.5–1 $m \cdot s^{-1}$ (1–2 knots) (Metcalf and Stalcup 1967), producing a strong northwestward longshore drift (Summerhayes *et al.* 1975).

In contrast to the muddy coastline north and west of the Amazon and the indented coastline between Belem and Sao Luis, the coastline east of Sao Luis is very sandy and generally smooth, embayments and estuaries being restricted to the mouths of the larger and some of the smaller rivers. Much of the shoreline consists of beaches and dunes.

Offshore, nearly the entire shelf consists of sand, which is essentially mud-free (Summerhayes *et al.* 1975). Organic contents of the sediments are very low, highest levels occurring off rivers such as the Jaguaribe, where there is a local source of nutrients (Summerhayes *et al.* 1975; cf. Barretto and Summerhayes 1975). Levels of suspended matter in the waters are very low (Barretto and Summerhayes 1975), probably because of their low productivity and nutrient levels (Okada 1960; Hela and Laevastu 1962), the tendency for fine material to remain trapped within estuaries in the region (Mabesoone and Coutinho 1970), and the low discharge of rivers from the drought polygon. One of the only rivers where sediments are known to be regularly discharged is at the cuspate delta of the Jaguaribe (Bacoccoli 1971). The mineral content of the sands reflects their history in terms of interaction of geological source, physiography, climate, and weathering, as well as transportation and deposition. The coastline is largely depositional, with sand dunes being blown inland from the coast. This has resulted in some areas of spectacular accumulation of sand, such as that along the coastline of the Lencois Maranhenses National Park west of Parnaiba.

Sandstone reefs are a feature of the northern and eastern Atlantic coasts of Brazil, occurring in both the littoral and nearshore zones in lines parallel to the shore.

Map 9.5 (Brazil-5)
Distribution of Nearctic shorebirds along the Fortaleza coast of Brazil



These beachrock formations are formed of cemented sands (Mabesoone 1964) and were reported by Darwin (1841), who knew they had not developed from coral. Two or three such reefs may be exposed at low tide, and there may be 10 or more submerged offshore. The reefs form along the beachline and are thus geologically recent; the lines of reefs reflect changes in the Holocene sea level, every line representing a temporary still-stand. The uppermost reefs are soft, with a hardened upper surface, and they become more consolidated offshore (Mabesoone 1964). Such outcroppings were observed along the extensive sandy section west of Parnaiba and have been reported between Fortaleza and the Rio Sao Francisco on the east coast (Mabesoone and Coutinho 1970). Similar formations have been reported on the coastal platforms of southern Brazil and Uruguay (Delaney, in Mabesoone 1964) and appeared to be present along the sandy southern coast of Buenos Aires province in Argentina (pers. obs.). These structures attract shorebirds on many beach areas where both are present.

9.5.2. Northeast eco-unit

Sectors 63–72; Maps 9.4 (Brazil-4) to 9.6 (Brazil-6)

Much of the coastline in the Northeast eco-unit was sandy, with only isolated inlets or lagoons (Tables 9.10, 9.12, and 9.14). Shorebird totals were moderate to low, the overall total of 6000 representing some 1.5% of the Brazilian total (Tables 9.9, 9.11, and 9.13).

Most of the small shorebirds (peeps) occurred in small lagoons or wet areas behind the ocean beach, such as those occurring in Sectors 67 and 72. Large numbers were not located during the surveys in the extensive complex of mangroves *Rhizophora mangle*, marshes, beaches, and dunes in the delta of the Rio Parnaiba between Tutoia and Parnaiba (Sector 64). Many of the areas of seasonally flooded wetlands that are found behind the coast, for instance near Aracati, were dry at the time of the surveys and contained relatively few birds.

Notable numbers of some shorebird species were found along the beaches of this eco-unit and appeared to be closely associated with patches of beachrock. Such habitats were observed regularly along the vast beaches and dune systems of the Lencois Maranhenses National Park (Sector 63) west of Parnaiba. Over half (230, or 60.5%) of the eco-unit total of 380 Sanderlings (8.7% of the North Coast total) occurred along this stretch of coast, which was also one of the few coastal localities in which Lesser Golden-Plovers (some 80) were observed. Ruddy Turnstones and Black-bellied Plovers were also associated with beachrock habitats. Of the total of 430 Ruddy Turnstones (2.1%

Table 9.11
Totals of Nearctic shorebirds in survey sectors in Map 9.5 (Brazil-5)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Dowit-cher species	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Total shore-birds
65	124.1	0	11	2	13	78	14	0	0	84	176	21	0	40	61	250
66	83.6	0	5	305	310	199	33	2	2	6	242	4	1	0	5	557
67	75.7	0	28	560	588	67	15	6	0	73	161	23	1	0	24	773
68	100.3	1	0	165	166	75	5	4	0	0	84	0	0	0	0	250
69	50.4	0	2	150	152	3	0	1	0	2	6	0	0	0	0	158
70	75.0	0	1	180	181	0	0	57	0	1	58	0	0	0	0	239
Total	509.1	1	47	1 362	1 410	422	67	70	2	166	727	48	2	40	90	2 227

Table 9.12
Principal habitats in survey sectors in Map 9.5 (Brazil-5)

Sector no.	Habitat description
65	Narrow sand beach, some mudflats by rivers, some rocky points / dunes, palms / sandy scrub, forest
66	Narrow sand beach, some mudflat with mangroves / dunes / scrubby desert lagoon, forest
67	Narrow sand beach, some mudflats / dunes / sandy scrub, forest, salt pans
68	Narrow sand outer beach, some small brackish muddy deltas / dunes / sandy scrub, palms, forest
69	Narrow sand beach, a few rocky outcrops / dunes / sandy scrub
70	Narrow sand beach, small brackish muddy estuary / dunes / sandy scrub, salt pans, small lagoons

of the North Coast total) counted in the eco-unit, 190 (43.4%) were found in Sector 63 and 160 (36.7%) in Sector 71, principally on the beaches. Black-bellied Plovers were most common in the eastern part of the eco-unit, with 740 (57.5%) of the total of 1300 (5.4% of the North Coast total) in Sectors 63 and 64 (Tables 9.9, 9.11, and 9.13).

9.6. Northeastern coast: Natal to Salvador

Shorebird surveys were not carried out in this sector, as logistical considerations precluded coverage of all of the very long Brazilian coastline, and extensive suitable habitat was not expected in this zone. Surveys of representative, fairly similar habitat were carried out to the north and south of the area, west of Aracati and from Salvador southwards, respectively.

The coastline is backed by mountains of the Precambrian Brazilian Coastal (Atlantic) Shield, which reach heights of 500–1000 m. There is a generally fairly narrow coastal plain, about 15 km in width between Joao Pessoa and Maceio and between Aracaju and Salvador, in which the coastline is steeply cliffed. The plain is wider, around 50 km, near Aracaju, and beaches and dunes with some lagoon developments occur in the area (Summerhayes *et al.* 1975).

The rainfall is high, usually exceeding 1000 mm·yr^{-1} and sometimes 2000 mm·yr^{-1} over the eastern coastal ranges, where the prevailing easterly and southeasterly winds deposit their moisture (Andrade 1964). The Rio Sao Francisco, the largest in the area, is some 2700 km in length; its upper drainage basin consists of Paleozoic metasediments, and it provides the major source of sediment and freshwater input on the coast. Even so, it appears that 90% of the sediment carried by the river is deposited within its own system, and the remaining 10% is deposited within 5–10 km of the river mouth (Barretto and Summerhayes 1975). Little or none of the suspended load of the other rivers in the region, which generally are short and drain a limited area because of the proximity of the coastal mountains, appears to reach the sea (Mabesoone and Coutinho 1970; Barretto and Summerhayes 1975; Summerhayes *et al.* 1975).

Organic contents of the submerged sediments are generally very low, being somewhat higher in the terrigenous muds off the Rio Sao Francisco and higher still in muds trapped behind reefs and in lagoons along the coast (Coutinho, in Summerhayes *et al.* 1975). Most of the river shelf sediments are sandy, although muddy sediments occur around the delta of the Rio Sao Francisco and are more plentiful farther offshore, especially south of Maceio. Although rainfall is high along the coast, the short river courses and luxuriant tropical vegetation until recently prevented extensive erosion of the heavily weathered soil (Gibbs 1967), so that little terrigenous detritus reached the sea. Erosion has increased considerably owing to the extensive removal of forest cover, especially since the middle of the present century. High wave energies along the coast (Coleman and Wright 1972) keep much of the sand in motion, precluding extensive organic growth on the inner shelf. Because of the lack of terrigenous input and the tropical climate, carbonate-producing organisms flourish, and biogenically produced carbonates predominate in the accumulated sediment offshore. The area is also unique in its almost total lack of coral and complete lack of ooids (Summerhayes *et al.* 1975). The offshore waters are generally unproductive (Okada 1960; Hela and Laevastu 1962), and, even near the Rio Sao Francisco, most organic matter (mainly diatoms) appears to be recycled within the water column, with only a small amount accumulating in the sediment (Barretto and Summerhayes 1975).

The west-flowing South Equatorial Current reaches the coast near Recife (Defaut 1961). The current splits, with the North Brazilian Coastal Current flowing north past Natal and then west along the north coast towards the Guianas at about 1 m·s^{-1} (Metcalf and Stalcup 1967), and the Brazil Current flowing southwards towards Rio de Janeiro at about 0.25–0.5 m·s^{-1}. In winter (June–August), a weak countercurrent flows north along the coast (US Naval Hydrographic Office 1967). Surface temperatures are in the range 26–29°C in summer (March; Fuglister 1960) and 25–27°C in winter (August; Cavalcanti *et al.* 1967). Salinities are around 36 ppt, although they are often lower near major rivers during periods of high discharge (Fuglister 1960; Cavalcanti *et al.* 1967).

Two narrow sedimentary basins occur along the coastline at the margin of the Brazilian Coastal (Atlantic) Shield: the Recife – Joao Pessoa Basin, running between the cities of those names, and the Sergipe–Alagoas Basin, running for about 350 km from north of Maceio (9°S) southwards to south of Aracaju (11°30′S) (Asmus and Ponte 1973). Both are filled with Cretaceous and Tertiary sediments. Beach sands, eolian sediments, dunes, and alluvial deposits occur along the coast (Asmus and Ponte 1973).

9.7. East coast: Salvador to Vitoria

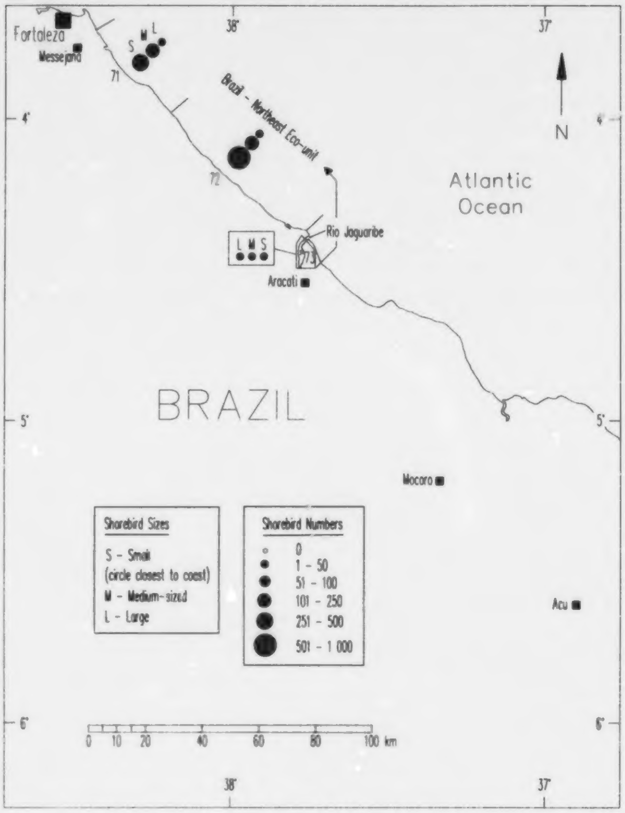
9.7.1. Environmental conditions

The east Atlantic coast of Brazil between Salvador and Vitoria is backed almost entirely by the Precambrian crystalline rocks of the Brazilian Coastal (Atlantic) Shield, which reach the coast in the vicinity of Ilheus. The hinterland is hilly, reaching 500–1000 m within 100 km of the sea; the highest elevations, up to 2884 m, are found inland from Vitoria. The coastal plain is very narrow and is set on three major geological basins: (1) the Reconcavo Basin, reaching the coast at Salvador and underlying the Baia de Todos os Santos; (2) the Jequitinhonha Basin, extending from south of Ilheus to north of Caravelas (15–17°S); and (3) the Espirito Santo Basin, extending from the mouth of the Rio Doce (19°45′S) to around Caravelas (17°30′S) (Asmus and Ponte 1973). A smaller basin, the Almada Basin, lies between the Reconcavo and Jequitinhonha basins north of Ilheus (Petri and Mendes 1983). The basins are filled with Cretaceous and Tertiary sediments, both of which occur north of Ilheus, the area south being cut into Tertiary sediments.

In the north, eolian fluviolacustrine sedimentation prevails (Asmus and Ponte 1973), and a number of extensive embayments and estuaries are found, including those at Salvador, comprising the Baia de Todos os Santos, and the two large systems south of Valenca and Itubera. The coastline north of Caravelas towards Ilheus, which is underlain by the Jequitinhonha Basin, is backed by low cliffs; similar shoreline is found towards Vitoria south of the Rio Doce. Between Caravelas and the Rio Doce, the Espirito Santo Basin is characterized by regression and the building of long sand bodies, so that beaches, bars, and spits, with some marshes and lagoons, are found (Asmus and Ponte 1973; de Melo *et al.* 1975). These areas were not covered on the surveys.

The climate of the area is hot and humid and has been termed "pseudo-equatorial" (Andrade 1964). Two rainy seasons occur, in March/April and in November/December. Precipitation falls mostly on the coastal ranges and principally in the northern section between Belmonte and Salvador, where it reaches 2000 mm·yr^{-1}. The hinterland is relatively dry, with rainfall in the range 500–1000 mm·yr^{-1}, the dry zone reaching the coast at the Rio Doce. Farther inland, the rainfall is again higher, exceeding 1000 mm·yr^{-1}. The principal rivers draining the area are the Jequitinhonha and Doce rivers, of which the Rio Doce is the larger: it is 630 km long, drains an area of 90 000 km^2, and discharges some 20 km^3 of water per year and an estimated 4×10^6 tons·yr^{-1} of sediment. The Jequitinhonha drains an estimated 70 000 km^2 and discharges some 8 km^3·yr^{-1} of water (de Melo *et al.* 1975; Milliman 1975). Both rivers discharge through cuspate deltas (Bacoccoli 1971), which effectively block the offshore movement of sand and gravel.

Map 9.6 (Brazil-6)
Distribution of Nearctic shorebirds along the Aracati coast of Brazil



Offshore, the Brazil Current moves south to southwestwards at about 0.3 m·s^{-1} (0.6 knots) (US Naval Hydrographic Office 1967), bringing warm saline water poor in nutrients. Several areas of upwelling are produced by the relatively complicated subsurface topography, particularly where the current diverges from the coast south of the Rio Doce and near the Royal Charlotte and Abrolhos banks.

Longshore drift may occur northwards between Ilheus and Salvador, and north and south on either side of Caravelas, where coastal outbuilding has occurred (de Melo *et al.* 1975).

Most of the inner shelf sediments are sandy, with muddy areas occurring off the major rivers (Rio Doce) or estuarine areas in the north (Valenca); these areas show the highest accumulation of organic matter (de Melo *et al.* 1975), the high carbon/nitrogen ratios probably reflecting the content of terrestrial plant material in these terrigenous sediments.

9.7.2. East eco-unit

Sectors 74–80; Map 9.7 (Brazil-7)

Surveys in the East eco-unit (Sectors 74–80) covered the bays and beaches from the vicinity of Salvador southwards to Ilheus. Much of the coastline is sandy, although fairly extensive mangrove development occurs around

Table 9.13
Totals of Nearctic shorebirds in survey sectors in Map 9.6 (Brazil-6)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turn-stone	Yellowlegs species	Red Knot	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
71	94.0	1	60	199	260	71	158	2	15	246	1	1	507
72	33.7	0	6	816	822	54	5	43	0	102	1	1	925
73	37.2	0	0	50	50	1	0	0	0	1	1	1	52
Total	164.9	1	66	1 065	1 132	126	163	45	15	349	3	3	1 484

Table 9.14
Principal habitats in survey sectors in Map 9.6 (Brazil-6)

Sector no.	Habitat description
71	Narrow sand beach, some small brackish muddy estuaries with mangroves, some rocky points / dunes, cliffs / scrubby desert, lagoon with palm forest
72	Narrow sand beach, some small brackish muddy estuaries with mangroves / dunes, palms / scrub, open forest, salt pans
73	Brackish estuary with mudbanks / forest, salt pans, lagoons

Salvador in the Baia de Todos os Santos (Sector 75) and around other major estuarine areas, including those near Valenca (Sector 77) and Itubera/Camamu (Sector 79) (Table 9.16). Despite the presence of suitable-looking habitat, however, few shorebirds were found in the latter areas (Table 9.15).

The Salvador Peninsula is a plateau made of Precambrian gneisses and granites of the Brazilian Coastal (Atlantic) Shield, generally covered with thick lateritic soils or coarse clastic late Tertiary rocks. It separates the Atlantic coast from the Baia de Todos os Santos, an enclosed embayment containing the estuary of the Rio Paraguacu. The bay is dotted with islands and fringed with mangrove stands. Alternating headlands and beaches are found around its shores, the cliffs being cut into bedded Cretaceous sandstones, siltstones, and shales. The sands are composed mostly of well-sorted quartz (Murphy and Schlanger 1962). Beaches tend to be larger and wider than on the outer Atlantic coast, with gentler slopes; extensive sandy and muddy flats are exposed at low tide and are well populated with pelecypods (Sestini 1967).

The Atlantic shoreline typically consists of a series of rocky headlands alternating with long stretches of gently curved or rectilinear beaches, or with coves and small bays. Most of the Atlantic beaches are narrow, 20–30 m at high tide and perhaps one-third wider at low tide, owing to the high angle of slope (3–5°), and are made up of quartz grains with a small percentage of skeletal fragments. Beach sands in the Bahia de Todos os Santos are finer grained and more calcareous than the outer beach sediments. Most quartz of the beach sands is derived from weathering of the basement gneisses, whereas that of the bay sands derives from breakdown of fine- and medium-grained Cretaceous sandstones. Outer beach areas are also exposed to ocean waves driven by the prevailing southeasterly trade winds, whereas those in the bay are in more sheltered waters.

Between the tip of the Salvador Peninsula and the harbour, the shore is mostly rocky, with small shingle and sand beaches. The southeast coast of Ilha de Itaparica consists of a long, wide, palm-lined beach, interrupted only in places by low cliffs of Cretaceous rocks.

South of Camamu and Itubera, there are extensive estuarine areas, with tidal mudflats, mangrove swamps dominated by *Rhizophora mangle*, brackish lagoons, and marshes. These areas are enclosed by low-lying islands fronted by long ocean beaches.

Totals of shorebirds observed on the surveys in the East eco-unit were surprisingly low, considering the extent of apparently suitable-looking habitat in the area. The eco-unit total of 2600 shorebirds represented only 0.7% of the Brazilian total (Table 9.15).

The majority of the shorebirds were found in bays and estuaries—most (2000, 76.0%) in the Baia de Todos os Santos, with smaller numbers in the estuaries south of Valenca (230) and Itubera (85). Small shorebirds were most numerous, with moderate to low numbers of Black-bellied Plovers, Ruddy Turnstones, yellowlegs, Whimbrels, and Willets. The estuary south of Itubera (Sector 79) was the farthest south that Willets were observed on the Atlantic coast during the present surveys.

Relatively few birds were found on the outer beaches, with the exception of the 230 Sanderlings in Sector 74 north of Salvador (Table 9.15), many of which were associated with the well-developed platforms of beachrock occurring along the shore. Fewer birds were seen on the beaches in the southern part of the eco-unit, where beachrock was less common. The picturesque sweep of tropical beach leading south to Ilheus (Sector 80) was spectacularly devoid of Nearctic shorebirds, only one Ruddy Turnstone being observed in some 36 km of shoreline.

9.8. Southern Brazil: Vitoria to Uruguayan border

Surveys were carried out in three areas of the southern coast of Brazil: (1) the Rio de Janeiro area, from Rio de Janeiro north to the Rio Paraiba do Sul/Cabo de Sao Tome (Rio eco-unit; Map 9.8 [Brazil-8], Sectors 81–89); (2) Sao Paulo area, from Santos south to Paranagua (Sao Paulo eco-unit; Map 9.9 [Brazil-9], Sectors 90–96); and (3) the Rio Grande do Sul coastline, from opposite Porto Alegre to near the Uruguayan border at the southern end of Lagoa Mirim (Rio Grande do Sul eco-unit; Map 9.10 [Brazil-10], Sectors 97–109, and Map 9.11 [Brazil-11], Sectors 110–120).

9.8.1. Environmental conditions

Much of the coastline in this region consists of sandy beaches, backed by a coastal plain of variable width. The mountains of the Precambrian Brazilian Coastal (Atlantic) Shield run along most of the coast, except in the Rio Grande do Sul eco-unit, and three sedimentary basins

Map 9.7 (Brazil-7)
Distribution of Nearctic shorebirds along the Salvador coast of Brazil

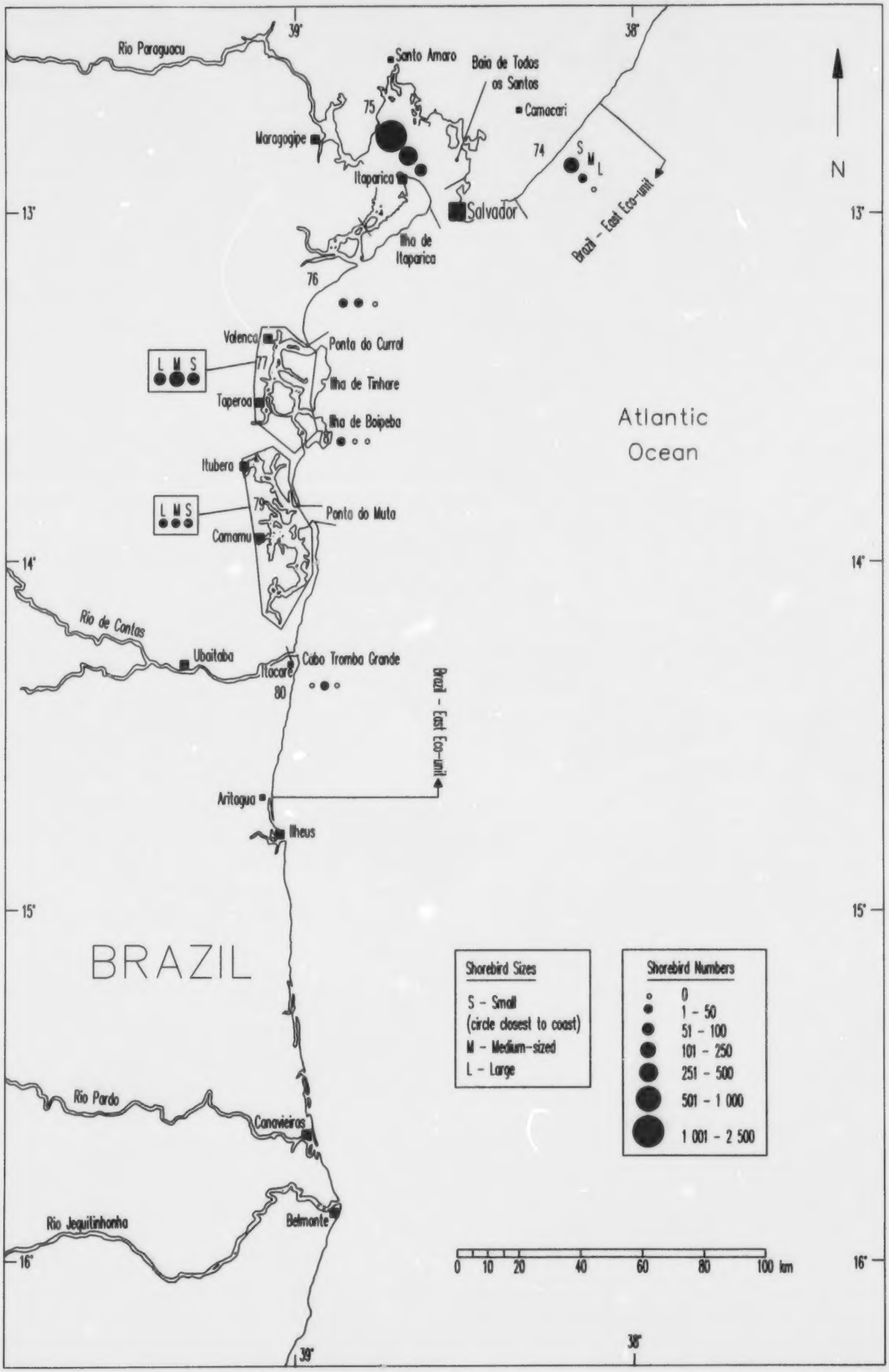

Rio Paraguacu
39°
38°
Santo Amaro
Baia de Todos os Santos
Camacari
75
Maragogipe
74
S M L
Itaparica
Salvador
Brazil - East Eco-unit
Ilha de Itaparica
13°
76
Valenca
Ponta do Curral
L M S
77
Ilha de Tinhare
Taperoa
Ilha de Boipeba
Itubera
L M S
79
Ponta do Muta
Camamu
14°
Rio de Contas
Ubaitaba
Cabo Tromba Grande
Itacare
80
Brazil - East Eco-unit
Aritagua
Ilheus
15°
BRAZIL
Atlantic Ocean
N
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
Rio Pardo
Canavieiras
Rio Jequitinhonha
Belmonte
16°
0 10 20 40 60 80 100 km

Table 9.15
Totals of Nearctic shorebirds in survey sectors in Map 9.7 (Brazil-7)

Sector no.	Sector length (km)	Spotted Sand-piper	Solitary Sand-piper	Pectoral Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Total large shore-birds	Total shore-birds
74	43.1	0	0	0	232	3	235	0	9	0	0	9	0	0	0	244
75	261.0	5	1	20	23	1395	1 444	113	277	48	52	490	43	28	71	2 005
76	122.0	1	0	0	4	38	43	7	16	1	0	24	0	0	0	67
77	214.9	9	0	30	0	18	57	34	6	4	79	123	18	36	54	234
78	72.9	1	0	0	2	0	3	0	0	0	0	0	0	0	0	3
79	189.1	4	0	15	0	16	35	14	12	6	0	32	5	13	18	85
80	36.0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1
Total	939.0	20	1	65	261	1 470	1 817	168	321	59	131	679	66	77	143	2 639

Table 9.16
Principal habitats in survey sectors in Map 9.7 (Brazil-7)

Sector no.	Habitat description
74	Narrow sand beach, rock outcrops / palms / habitations, lagoons
75	Broad mud- and sandflats, rocky shelves, mangroves / forested hills, industrial development
76	Sand beach, rocky shelves, some mangroves and mudflats / some palms, scrub / forest, habitations
77	Brackish estuary with large mudbanks, mangroves / forest
78	Sand beach, rocky reefs, some muddy bays and mangroves / palm plantations, forest
79	Brackish estuary with broad mudbanks, mangroves / forest
80	Narrow sand beach, steep rocky sections / palms / forested hills

are found—the Campos, Santos, and Pelotas basins (Asmus and Ponte 1973).

In the northern part of the region, north of Cabo Frio, the coastal plain opens to around 50 km at Campos, where the Rio Paraiba do Sul reaches the coast north of Cabo de Sao Tome. The extensive Lagoa Feia lies behind the coast in this area, although its well-vegetated freshwater borders do not provide a great deal of habitat for shorebirds. Numerous shallower small lagoons are found behind the outer barrier ocean beach; some containing more open habitat held large numbers of yellowlegs. Availability of such habitats depends on the specific topography of the individual lagoons/pools and the seasonally variable water levels. Some mangrove development occurred at the mouth of the Rio Paraiba do Sul.

The coastal strip is rather narrow between Cabo Frio and Rio de Janeiro. Several large brackish and saline lagoon systems are found behind the outer barrier beaches. Salt evaporation pans have been built in the lagoons immediately west of Cabo Frio, but the larger lagoons towards Rio de Janeiro are deeper and have less shoreline habitat. The area has become popular with holidaymakers: housing developments are found around many lagoons, and some beaches are crowded with people. Eutrophication has led to some lagoons becoming congested with vegetation, and increased disturbance through hunting and recreation has led to their deterioration as wildfowl or shorebird habitat. The shoreline of Baia de Guanabara at Rio de Janeiro, which once held extensive mangrove formations, has been extensively developed and polluted.

The mountains of the Serra do Mar run very close to the sea between Rio de Janeiro and Sao Paulo, rising to heights of up to 1000 m within 10 km of the sea; in some places, elevations exceed 2000 m. Surveys were not conducted along this precipitous coast.

The crystalline Precambrian rocks continue southwards into southeastern Rio Grande do Sul, in the high ranges of the Serra do Mar and Serra Geral; elevations reach 1000 m and in some places over 1900 m (Fuck *et al.* 1969). These mountains limit the coastal plain to a rather narrow strip for most of the distance, the Serra Geral coming close to the coast near Torres in Rio Grande do Sul. As a result, most rivers in the southern part of the area flow westwards into the Rio Parana system. The coast, in contrast, is drained by many short, small streams, which generally carry small amounts of sediment (da Rocha *et al.* 1975). Although rain-driven floods may bring large amounts of sediment to the coast, little of this material appears to reach the inner shelf offshore (Milliman and Santana, in da Rocha *et al.* 1975), and most is deposited within the coastal lagoons or estuaries or along the shoreline itself (da Rocha *et al.* 1975). The crystalline rocks constitute the source area for the sandy and argillaceous sediments on the coastal plain (Anon. 1975).

South of Santos, long sandy beaches run along the coast to the hilly outcrops at Peruibe. From Iguape to Ilha do Cardoso, the outer beach is backed by a large river channel running parallel to the shore. The estuaries at Paranagua and at Cananeia contain extensive mangrove developments. The southern limits of mangroves are reached at Florianopolis (27°30′S) for *Rhizophora mangle* and *Avicennia schaueriana*, and at the Rio Ararangua (29°S) for *Langucularia racemosa* (Lamberti 1969; Souza Sobrinho and Klein 1969; West 1977). In general, the coastal lowlands are poorly developed in the states of Parana and Santa Catarina. The coastal sediments consist of a relatively thick layer of marine and continental Quaternary/modern deposits (Fuck *et al.* 1969).

South of Laguna, the coastal plain contains a number of lakes and lagoons, but it is not until south of Tramandai that the coastal plain opens out extensively, elevations not exceeding 200 m westwards all the way to the Rio Uruguai, except for the Precambrian outcroppings west of the Lagoa dos Patos, which rise to some 600 m (Anon. 1975).

The coastal plain of Rio Grande do Sul comprises some 47 100 km^2 of lowlands; it is composed of Pleistocene and Recent sediments and contains many lakes and lagoons (Delaney 1965; Pinto 1966; Pinto and Ornellas 1970). The largest lagoon is the Lagoa dos Patos, which is 250 km

Ocean beaches, Rio Grande do Sul, southern Brazil. The very long ocean beaches fronting the sandy coastal plain in Rio Grande do Sul province in southern Brazil support some of the most significant concentrations of Sanderlings on the Atlantic coast of South America.

long, has an area of 9910 km^2, and is generally shallow, depths ranging from 6–8 m in the middle to 0.5–3 m at the margins (Closs and Madeira 1968; Anon. 1975). The Lagoa dos Patos receives water from the Rio Guaiba and its tributaries, the Camaqua River and the Lagoa Mirim. Salinity in the lower part of the lagoon near Rio Grande varies considerably, owing to seawater entering its channel; the remainder of the lagoon usually contains fresh water. The very low gradient of the lagoon floor (about 1 m in 120 km) results in wind direction and volume of runoff being the most important factors controlling water movements, and strong southeasterly winds occasionally bring saline water well north into the lagoon. Northeasterly winds predominate, although westerly continental winds occur in the fall and winter months (Closs and Madeira 1968). The lagoon is thought to have originated by development of a multiple sand barrier during up to four cycles of transgression and regression resulting from eustatic sea-level changes during Quaternary times (Villwock 1978). Bottom sediments are fine sand and silt, mostly derived from the Precambrian highlands (Closs 1963; Martins 1963; Villwock 1978). Biological activity is minor and related to a small mollusc assemblage (Villwock 1978).

Lagoa Mirim is the second largest lagoon, with an area of 3770 km^2 and depths up to 7 m (Delaney 1965).

Considerable numbers of smaller lagoons are found between the ocean beach and the larger lagoons inland, varying in size, depth, and salinity regime. The most important for shorebirds is the Lagoa do Peixe, situated between the Lagoa dos Patos and the ocean. It is some 40 km long, occupies an area of about 50 km^2, and is shallow, reaching depths of about 3 m, although much of the lagoon is less than 1 m deep. The lagoon is connected to the sea by a channel, near which saline to brackish conditions prevail, and there are extensive muddy, wet borders. The mouth of the lagoon is periodically blocked by moving sand and may be reopened by dredging (Delaney 1965) or by storm surges.

The coastline of Rio Grande do Sul forms one of the world's longest uninterrupted beaches: it is some 620 km in length (Martins 1967; Pinto and Ornellas 1970), and elevations reach 20 m at the crests of sand dunes. The major lagoons in the south are separated from the ocean by several kilometres of marine and eolian sands. The Pleistocene–Holocene–Recent sands extend westwards to the border of the Precambrian rock hills that outcrop in an arcuate belt from the Rio Guaiba to Pelotas (Closs and Madeira 1968), although the surface material consists of fluviatile clayey sediments between the lagoons and inland slopes (Anon. 1975).

Cabo Frio effectively marks the transition from a tropical environment farther north to a subtropical environment to the south. Mean annual temperatures range from 22 to 24°C from Rio de Janeiro northwards, from 20 to 22°C from about Sao Francisco do Sul to Rio de Janeiro, and from 18 to 20°C from Rio Grande to Sao Francisco do Sul (IBGE 1977). South of Rio de Janeiro, the climate can be classified as subtropical, and the southern Brazilian coastal climate can be classified as Cfa (subtropical humid without dry season and with warm summers [temperatures $>22°$C]) on the Koppen system. The rainfall is heavy over the coastal regions, especially where polar air masses from the south meet the Serra do Mar range. Mean annual precipitation is generally 1500–2000 mm · yr^{-1} from Rio de Janeiro to Florianopolis, 1250–1500 mm · yr^{-1} southwards to Rio Grande do Sul, and 1000–1250 mm · yr^{-1} along the southern coast (IBGE 1977). The mountainous areas of the Serra do Mar and Serra Geral have some of the highest rainfall recorded in Brazil, with means of over 3500 mm · yr^{-1} and maximum values of over 6500 mm · yr^{-1} in Sao Paulo state (Anon. 1975). The prevailing winds are generally northeasterly (Andrade 1964; Santos 1965; Bigarella 1970–71).

In Rio Grande do Sul, mangroves do not occur, but beach areas may be colonized by *Sesuvium portulacastrum*, *Salicornia gaudichaudiana*, and *Spartina* spp., and dunes with *S. portulacastrum*, *Cotula coronopifolia*, *Parricum reptans*, *Alternathera* spp., *Heliotropum reptans*, *Solanus sisymbrifolium*, and *Hyptio labiadas* (Delaney 1965).

Offshore, the most significant oceanographic features are the upwelling that occurs from Vitoria to Rio de Janeiro and the northward flow of cold waters into the southern areas. Upwelling is strongest in the north in the area of Cabo Frio, and biological productivity is relatively high thereabouts (Okuda 1962). Bottom sediments in the area show only slightly elevated levels of nitrogen, and the impact of upwelling is not clearly shown in these sediments, probably because the high wave and current energies and high oxygen levels that occur between Cabo Frio and Vitoria facilitate high rates of recycling of organic matter within the water column (da Rocha *et al.* 1975).

In the south, the Falkland (Malvinas) Current brings cool, less saline water northwards along the coast, especially in the autumn, when southwest winds push the Falkland (Malvinas) Current northeastwards and the Brazil Current farther offshore. The Falkland (Malvinas) Current reaches its maximum development during the winter, when cool waters invade north of Santa Catarina state, dipping below the surface before upwelling at Cabo Frio; in the spring, winds shift to northeasterly, and the Brazil Current again dominates the coastal circulation (Emilsson 1961).

Sand and gravel dominate the inner shelf sediments, especially along the southern coast. Belts of mud are found on the middle shelf, and some of these, especially in the Pelotas Basin, may represent old lagoonal structures now submerged, similar to those along the present coastline (da Rocha *et al.* 1975; Milliman 1978). The composition of the sediments off the southern part of the coast indicates that they are derived from material discharged from the Rio de la Plata and carried northwards by prevailing currents, perhaps during a period of earlier lower sea level (Urien 1972; da Rocha *et al.* 1975). In contrast, sediments off the northern part of this sector appear to consist principally of material from the Precambrian rocks of the coastal highlands carried down by the short east coast rivers. In the south, an area of mud is also found off the Rio Grande channel draining the Lagoa dos Patos, representing sediments derived from the lagoon (Martins *et al.* 1972; da Rocha *et al.* 1975).

9.8.2. Rio eco-unit

Sectors 81–89; Map 9.8 (Brazil-8)

The Rio eco-unit contained low numbers of shorebirds. The total of 5600 represented 1.4% of the Brazilian total and consisted mostly of yellowlegs (4800) and Sanderlings (520) (Table 9.17).

The Rio Paraiba do Sul marked the northern limit of the coastline surveyed for shorebirds. River levels were very high in January 1983, with extensive flooding occurring through the mangrove areas behind the outer barrier sand beach at the mouth of the river delta and in the adjacent open grassy fields surrounding the river channel farther inland.

The deltaic protrusion of the Rio Paraiba do Sul has been formed largely by Holocene beach ridge progradation (Dias 1981). The area is rather flat and contains a complex of relatively shallow lakes and marshes inland, mangrove swamps at the mouth of the river, and sandy beaches along the shoreline backed by a series of small, brackish lagoons (Table 9.18). Very few shorebirds were seen along the beaches between Atafona, at the mouth of the river, and Cabo de Sao Tome (Sector 84). Small numbers of Sanderlings (35) occurred along the beach between Cabo de Sao Tome and Macae (Sector 85), but the most significant shoreline habitat along this stretch appeared to be the shallow lagoons behind the beach, which contained most of the yellowlegs (330), Black-bellied Plovers (80), and small shorebirds (peeps) (10) (Table 9.17). The largest lake inland is the Lagoa Feia, of some 167 000 ha (in 1978, reduced from about 300 000 ha in 1933 through drainage schemes), which is an important area for resident and migratory waterfowl (Scott and Carbonell 1986). Much of the lagoon shoreline is well vegetated and surrounded by agricultural fields, with few muddy margins, and there was very little suitable shorebird habitat along its borders. With water levels in the lake controlled, it is unlikely that muddy margins would develop. Very few Nearctic shorebirds were observed around Lagoa Feia (Sector 83) or adjacent lagoons (Sector 84) (only a few yellowlegs), although South American species such as the Southern Lapwing *Vanellus chilensis* and jacanas were common in the surrounding areas.

The most significant numbers of shorebirds were found in shallow, flooded areas of open mud surrounded by fields with short vegetation; such areas were located to the north and east of the Lagoa Feia behind the coast between Cabo de Sao Tome and the Rio Paraiba do Sul. Very large numbers of yellowlegs used these areas: some 4500 were counted in Sector 82, in flocks of up to 1800 birds. These numbers were among the largest found in nearshore habitats along the Atlantic coast, the eco-unit total of 4800 representing 78.8% of the regional Atlantic Coast total and 5.3% of the South American total (Table 9.17).

Only a few Sanderlings were observed on the coast south of Macae (Sector 86), where a series of beaches and rocky points run south to Cabo Frio (Sector 87), a hilly promontory connected to the mainland by a broad sandy isthmus and bordered by curving beaches.

Between Rio de Janeiro and Cabo Frio, a series of lagoons has been formed by the sealing off of former embayments by Holocene barrier deposition; both an inner barrier, relating to a higher Holocene sea-level phase, and an outer barrier, relating to the present sea level, may generally be found. Barrier sediments are derived from the seafloor, whereas fluvial sediments are trapped within the lagoon systems (Muehe 1979). The lagoons vary from brackish to saline, the largest being the Lagoa de Araruama (15 000 ha). Some mangrove development occurs in brackish areas, although many of the lagoon shorelines are well vegetated and without muddy margins. Large areas of salt pans have been excavated from marshes or shallow lagoon areas towards Cabo Frio. Long sandy beaches run along the coast. Lagoon, salt pan, and shoreline habitats were all sampled in Sector 88. Sanderlings comprised nearly all of the shorebirds observed, most occurring in one large flock (400) on the outer beach towards the western end of the sector; the majority of the remaining birds were observed in the salt pans.

The heavily urbanized Baia de Guanabara at Rio de Janeiro, once an area of extensive mangrove development, was not surveyed, and no shorebirds were found on surveys of the coast west of the city (Sector 89).

Map 9.8 (Brazil-8)
Distribution of Nearctic shorebirds along the Rio de Janeiro coast of Brazil

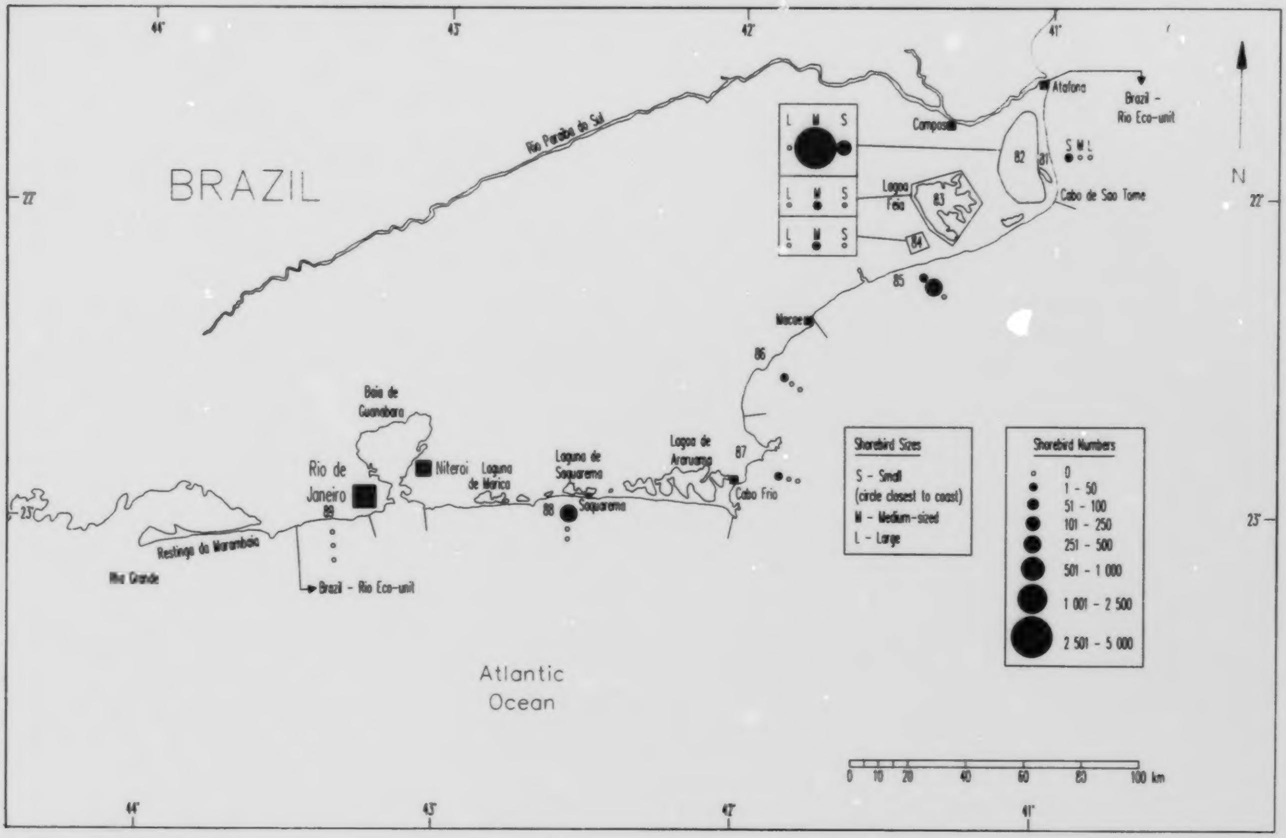

44°
43°
42°
41°
22°
23°
BRAZIL
Rio Paraiba do Sul
Atafona
Brazil - Rio Eco-unit
Campos
L M S
82
81
S M L
Cabo de Sao Tome
Lagoa Feia
83
84
85
N
Macae
86
Baia de Guanabara
Rio de Janeiro
89
Niteroi
Laguna de Marica
Laguna de Saquarema
Saquarema
88
Lagoa de Araruama
87
Cabo Frio
Restinga da Marambaia
Ilha Grande
Brazil - Rio Eco-unit
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
Atlantic Ocean
0 10 20 40 60 80 100 km

Table 9.17
Totals of Nearctic shorebirds in survey sectors in Map 9.8 (Brazil-8)

Sector no.	Sector length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Total medium-sized shorebirds	Total large shorebirds	Total shorebirds
81	47.0	1	0	0	1	0	0	0	0	0	1
82	0.0	1	0	151	152	0	0	4 470	4 470	0	4 622
83	0.0	0	0	0	0	0	0	3	3	0	3
84	0.0	0	0	0	0	0	0	5	5	0	5
85	100.0	0	35	10	45	76	1	330	407	0	452
86	53.0	0	4	0	4	0	0	0	0	0	4
87	60.0	0	2	0	2	0	0	0	0	0	2
88	110.0	0	483	1	484	0	0	0	0	0	484
89	24.9	0	0	0	0	0	0	0	0	0	0
Total	394.9	2	524	162	688	76	1	4 808	4 885	0	5 573

Table 9.18
Principal habitats in survey sectors in Map 9.8 (Brazil-8)

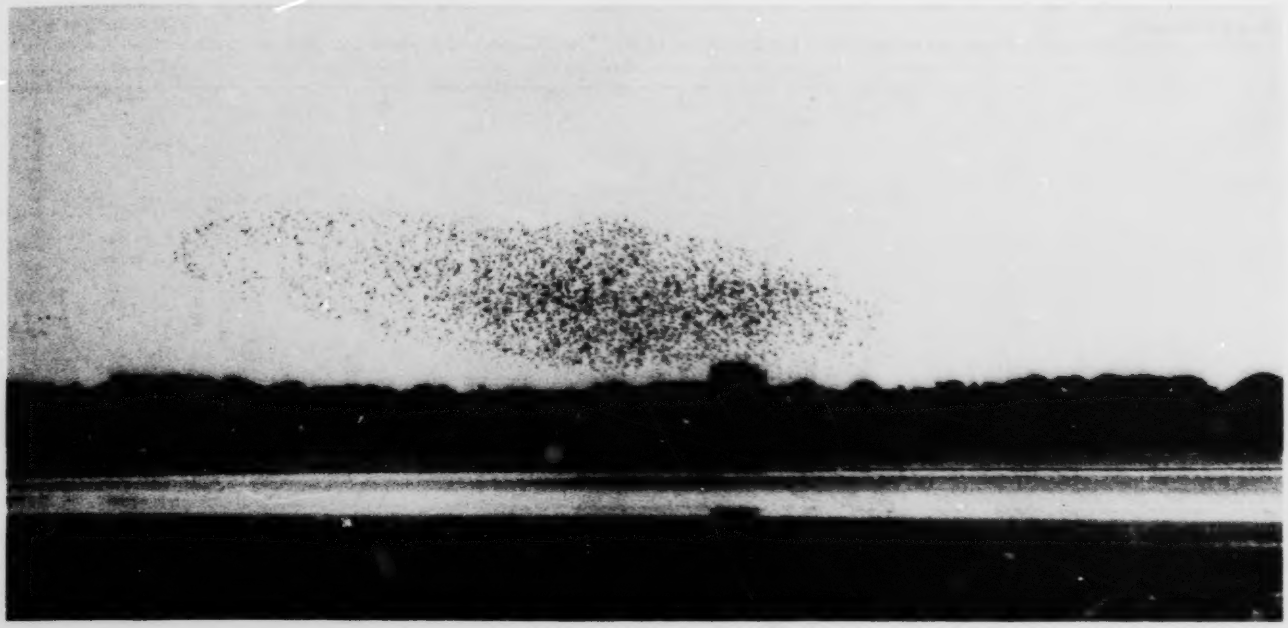
Sector no.	Habitat description
81	Sand beach / farmland, scrub, marsh, lagoons
82	Inland; freshwater lagoons with marshy mudflats / farmland
83	Inland; freshwater lagoon with marshy edges / farmland
84	Inland; freshwater lagoon with marshy mudbanks / farmland
85	Narrow sand beach / farmland, small lagoons, marsh
86	Narrow sand beach, rocky points / forests, marsh / farmland
87	Narrow sand beach, rocky points / rocky, partly forested hills, habitations, farmland
88	Sand beach / habitation, farmland, salt pans, lagoons
89	Freshwater lagoon, marsh / urban area

9.8.3. Sao Paulo eco-unit

Sectors 90–96; Map 9.9 (Brazil-9)

The Sao Paulo eco-unit had the lowest overall total of Nearctic shorebirds found on the surveys—a mere 12, of which 10 occurred in one flock of peeps along the Praia da Jureia in Sector 92 (Table 9.19).

The northern end of the eco-unit is marked by a high mountainous promontory running out from the Serra do Mar to form the steep Ilha de Sao Sebastiao. Most of the coastline consists of long, straight, sandy beaches, whose outlines relate to the prevailing southeasterly wave action (Table 9.20). The beaches are interrupted periodically by residual outcroppings of coastal massif, as at



Lagoa do Peixe, southern Brazil. Shallow, brackish lagoons occurring near the coast in southern Brazil and in Uruguay provide important habitats for Nearctic shorebirds, both during the wintering period and on migration. A flock of Red Knots is pictured during northward migration in April.

Iguape, Jureia, Itatins, and Itanhaem. Ilha Comprida is an elongated, low, sandy barrier island; behind it a river leads to the mangrove-lined lagoons and swamps at Cananeia, which are enclosed by Pleistocene and Holocene barrier beaches and the hilly Ilha do Cardoso (Bigarella 1978). The Baia de Paranagua and Baia de Laraneiras, between Paranagua and Guaraquecaba, form a large sea bay with a complex indented coastline and many small islands; several small rivers enter the bay, and there are extensive marsh and mangrove formations around its borders. Tidal ranges are about 1–1.5 m.

Both the outer shoreline and the bays and channels were surveyed. Despite apparently suitable habitat along the ocean beaches and along some of the river channels and bays, shorebird numbers were exceptionally low. Extensive intertidal habitat was not observed in most of the larger bays during the flights, and vegetation generally bordered the water directly.

Even though few shorebirds were observed during the January surveys, it does appear that the beaches in this eco-unit are used heavily during migration periods, as suggested by the many specimens of shorebirds that have been collected in the area at such times (unpubl. results).

9.8.4. Rio Grande do Sul eco-unit

Sectors 97–120; Maps 9.10 (Brazil-10) and 9.11 (Brazil-11)

The coastline of Rio Grande do Sul in southern Brazil contains some of the most important shorebird habitats in the country. A total of 25 800 shorebirds was counted in the eco-unit, comprising some 6.5% of the regional total for the Atlantic Coast (Tables 9.21 and 9.23). Most (24 100 or 93.2%) consisted of small species, among which peeps (15 100) were most common: the majority of these consisted of White-rumped Sandpipers, of which a further 2300 were identified from the air. The inclusive total of 17 500 peeps/White-rumped Sandpipers represented 23.9% of the Atlantic Coast total of 73 000, making southern Brazil the second most important area discovered in the region after Tierra del Fuego. Moderate numbers of White-rumped Sandpipers/peeps occurred along the outer ocean beach (total 3200), especially in the northern part of the coast between Pinhal and Rio Grande (Sectors 97–103), with fewer occurring south of Rio Grande (Sectors 110–115). The majority (14 200, or 81.6% of the total) of shorebirds in this category were found in lagoon habitats, especially in the saline lagoons between the Lagoa dos Patos and the Atlantic Ocean: the Lagoa do Peixe (Sectors 106 and 107, total 11 900) was by far the most important location and contained large areas of exposed mudflats on which the birds were found (Table 9.22). Smaller numbers occurred on the sandy shorelines of the freshwater lagoons (e.g., Lagoa dos Patos, Sectors 104, 105, and 109; Lagoa Mangueira, Sectors 116–118; and Lagoa Mirim, Sector 120), or in marshy areas of wetland as found near Taim (Sector 119) (Table 9.24).

The ocean beaches of Rio Grande do Sul were the most important wintering area discovered for Sanderlings on the Atlantic coast of South America, the eco-unit total of 6600 representing 71.3% of the regional Atlantic Coast total (Tables 9.21 and 9.23). The species was again much more common north of Rio Grande than south of the city, particularly along the coastline in the vicinity of the Lagoa do Peixe (Sectors 99–101), where the majority of birds (5500) occurred (Table 9.21).

Important concentrations of Lesser Golden-Plovers were found in the eco-unit. The total of 630, representing 16.1% of the Atlantic Coast total of 3900, was the only significant number found in coastal or nearshore habitats outside Uruguay (Tables 9.21 and 9.23). Lesser Golden-Plovers were found along the ocean beaches (390, 62.6%), as well as in lagoon and nearby grassland habitats (240, 37.4%). Ground observations in February 1985 of an estimated 6000–10 000 birds confirmed the importance of the Lagoa do Peixe area for this species (unpubl. results).

Map 9.9 (Brazil-9)
Distribution of Nearctic shorebirds along the Santos coast of Brazil

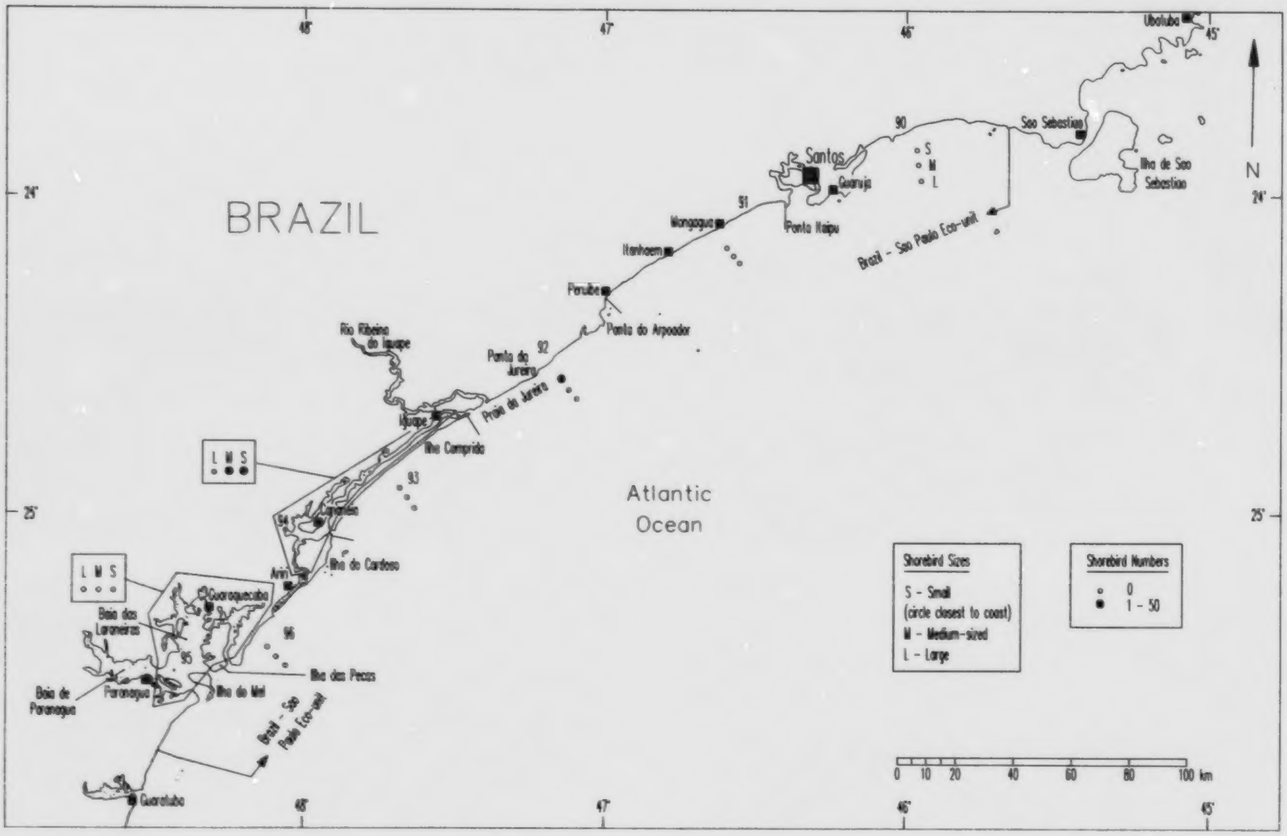

48°
47°
46°
45°
24°
25°
Ubatuba
N
90
Sao Sebastiao
Ilha de Sao Sebastiao
Santos
Guaruja
S
M
L
BRAZIL
91
Mongagua
Itanhaem
Ponta Itaipu
Brazil - Sao Paulo Eco-unit
Peruibe
Ponta do Arpoador
Rio Ribeira do Iguape
Ponta do Jureia
92
Praia da Jureia
Iguape
Ilha Comprida
L M S
93
Atlantic Ocean
Cananeia
94
Ilha do Cardoso
Ariri
Guaraquecaba
Baia dos Laranjeiras
95
96
Ilha das Pecas
Baia de Paranagua
Paranagua
Ilha do Mel
Brazil - Sao Paulo Eco-unit
Guaratuba
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
○ 0
● 1 - 50
0 10 20 40 60 80 100 km

Table 9.19
Totals of Nearctic shorebirds in survey sectors in Map 9.9 (Brazil-9)

Sector no.	Sector length (km)	Unidentified small shorebird species	Total small shorebirds	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Total large shorebirds	Total shorebirds
90	96.5	0	0	0	0	0	0
91	82.0	0	0	0	0	0	0
92	73.0	10	10	0	0	0	10
93	61.0	0	0	0	0	0	0
94	62.0	1	1	1	1	0	2
95	325.0	0	0	0	0	0	0
96	85.0	0	0	0	0	0	0
Total	784.5	11	11	1	1	0	12

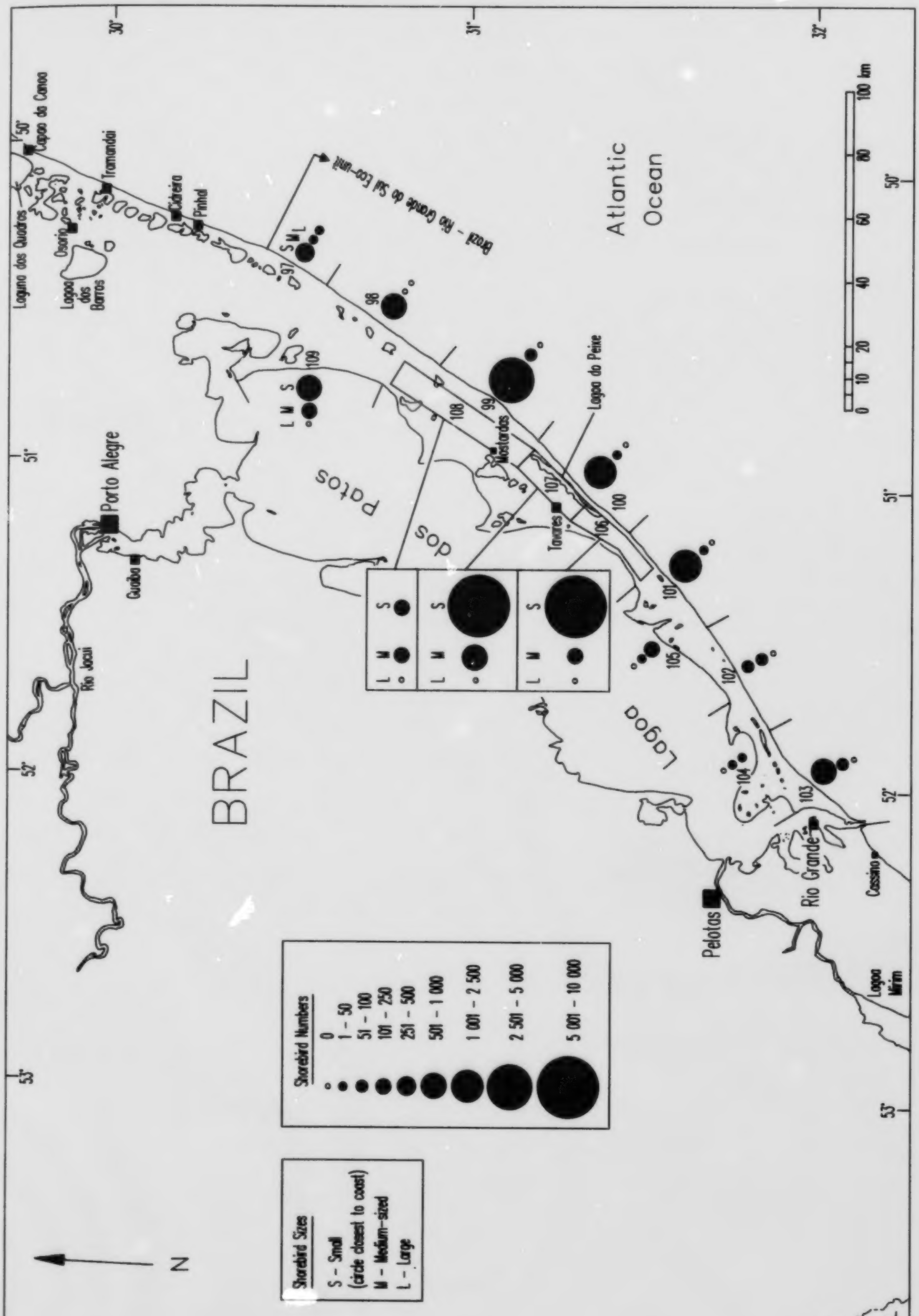
As well as being an important wintering area for Nearctic shorebirds, the Lagoa do Peixe is also of outstanding international importance as a stopover area, especially for shorebirds on northward migration. Over 10 000 Red Knots and 3000 Hudsonian Godwits have been observed during migration periods at the lagoon, many attaining high weight levels, indicating that the lagoon may be a critical area where birds put on the fat required to fuel long-distance flights across Amazonia en route to their breeding grounds in North America (unpubl. results; Harrington *et al.* 1986).

Lagoon shorelines, particularly those between Rio Grande and the Lagoa do Peixe area, held significant numbers of yellowlegs (420, 6.9% of the Atlantic Coast total; Tables 9.21 and 9.23).

Table 9.20
Principal habitats in survey sectors in Map 9.9 (Brazil-9)

Sector no.	Habitat description
90	Sand beach, some mangroves by river / scrubby forest, habitations
91	Sand beach / scrub, habitations
93	Sand beach / scrub, habitations
94	Brackish river channel; mudbanks and flats, mangroves / sandy scrub
95	Brackish lagoon; some mudflats edged by low mangroves / forest
96	Sand beach / sandy scrub

Map 9.10 (Brazil-10)
Distribution of Nearctic shorebirds along the northern sectors of Rio Grande do Sul state, Brazil


Laguna dos Quadros
Capao da Canoa
Tramandai
Osorio
Cidreira
Pinhal
Lagoa dos Barros
Brazil - Rio Grande do Sul Eco-unit
Atlantic Ocean
Porto Alegre
Guaiba
Rio Jacui
BRAZIL
Lagoa dos Patos
Mostardas
Tavares
Lagoa do Peixe
Pelotas
Rio Grande
Cassino
Lagoa Mirim
URUGUAY
97
98
99
100
101
102
103
104
105
106
107
108
109
S M L
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
N
0 10 20 40 60 80 100 km
30°
31°
32°
50°
51°
52°
53°

Map 9.11 (Brazil-11)
Distribution of Nearctic shorebirds along the southern sectors of Rio Grande do Sul state, Brazil

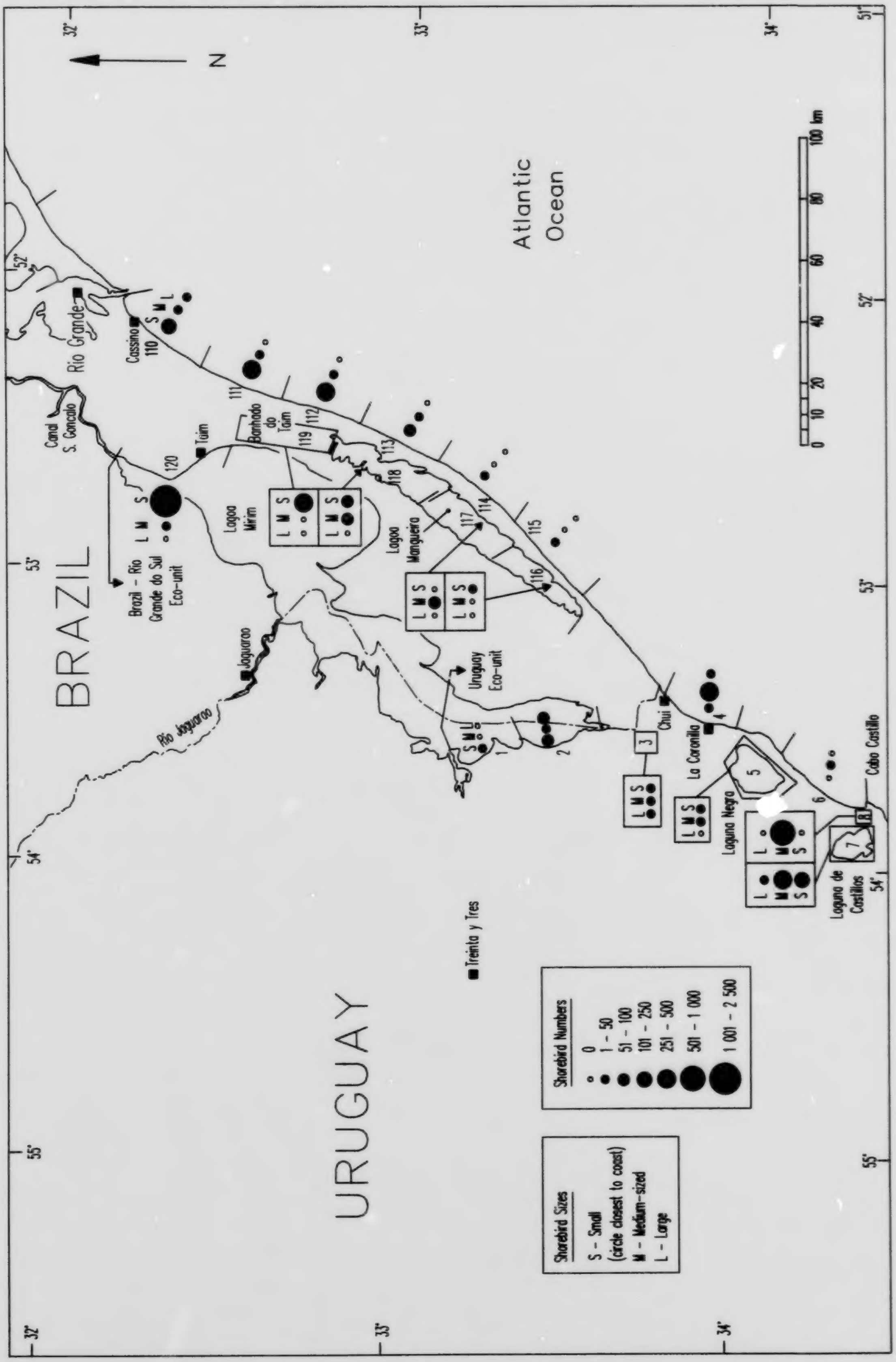

N
BRAZIL
URUGUAY
Atlantic Ocean
Rio Grande
Cassino
Canal S. Goncalo
Taim
Banhado do Taim
Lagoa Mirim
Lagoa Mangueira
Brazil - Rio Grande do Sul Eco-unit
Uruguay Eco-unit
Jaguarao
Rio Jaguarao
Chui
La Coronilla
Laguna Negra
Cabo Castillo
Laguna de Castillos
Treinta y Tres
110
111
112
113
114
115
116
117
118
119
120
1
2
3
4
5
6
7
8
S M L
L M S
32°
33°
34°
51°
52°
53°
54°
55°
0 10 20 40 60 80 100 km
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500

Table 9.21
Totals of Nearctic shorebirds in survey sectors in Map 9.10 (Brazil-10)

Sector no.	Sector length (km)	Pectoral Sand-piper	White-rumped Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shorebirds	Lesser Golden-Plover	Yellowlegs species	Uniden-tified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
97	24.9	0	120	50	267	437	0	0	2	2	3	3	442
98	39.1	0	612	0	380	992	0	0	0	0	0	0	992
99	37.5	0	189	2 600	23	2 812	70	0	2	72	0	0	2 884
100	38.2	0	327	1 408	41	1 776	18	0	0	18	0	0	1 794
101	38.8	0	565	1 467	71	2 103	38	0	0	38	0	0	2 141
102	39.0	0	0	0	51	51	100	0	0	100	0	0	151
103	35.8	0	136	452	38	626	88	0	0	88	0	0	714
104	42.9	0	0	0	30	30	0	29	0	29	0	0	59
105	32.1	0	50	0	73	123	3	26	2	31	0	0	154
106	51.3	1	0	0	5 005	5 006	62	165	0	227	0	0	5 233
107	20.2	0	0	0	6 902	6 902	0	0	610	610	0	0	7 512
108	57.9	0	0	0	160	160	170	10	0	180	0	0	340
109	48.8	0	40	0	515	555	0	149	0	149	0	0	704
Total	506.5	1	2 039	5 977	13 556	21 573	549	379	616	1 544	3	3	23 120

Table 9.22
Principal habitats in survey sectors in Map 9.10 (Brazil-10)

Sector no.	Habitat description
97	Narrow sand beach / dunes / scrubby desert
98	Narrow sand beach / dunes / scrubby desert
99	Narrow sand beach / dunes / scrubby desert
100	Narrow sand beach / dunes / scrubby desert, lagoons
101	Narrow sand beach / dunes / scrubby desert
102	Narrow sand beach / dunes / scrubby desert
103	Narrow sand beach / dunes / scrubby desert, farmland
104	Freshwater wetland and lagoon shore; marsh / farmland
105	Freshwater lagoon shore; sandflats and bars, marsh / farmland
106	Inland; brackish wetland with broad mudflats / farmland, scrub, sand beach
107	Inland; brackish wetland with broad mudflats / farmland, scrub, sand beach
108	Inland; small freshwater lagoon with muddy margin and steep banks / grassland, farmland
109	Freshwater lagoon shore; sand beach and flats / pastures, marsh

Table 9.24
Principal habitats in survey sectors in Map 9.11 (Brazil-11)

Sector no.	Habitat description
110	Narrow sand beach / dunes / scrubby desert
111	Narrow sand beach / dunes / scrubby desert, forestry plantation
112	Narrow sand beach / partially vegetated dunes / scrubby desert
113	Narrow sand beach / partially vegetated dunes / scrubby desert
114	Narrow sand beach / dunes / scrubby desert
115	Narrow sand beach / dunes / scrubby desert
116	Freshwater lagoon shore; sand beach, marsh / scrubby desert
117	Freshwater lagoon shore; sand beach, marsh / scrubby desert
118	Freshwater lagoon shore; sand beach, marsh / farmland
119	Inland; freshwater wetlands and marsh / farmland
120	Freshwater lagoon shore; sandflats with pools, steep banks in places / marsh / farmland

Table 9.23
Totals of Nearctic shorebirds in survey sectors in Map 9.11 (Brazil-11)

Sector no.	Sector length (km)	White-rumped Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shorebirds	Lesser Golden-Plover	Black-bellied Plover	Yellowlegs species	Uniden-tified medium-sized shorebird species	Total medium-sized shorebirds	Uniden-tified large shorebird species	Total large shorebirds	Total shorebirds
110	38.5	65	165	0	230	20	0	0	0	20	4	4	254
111	28.4	80	158	35	273	31	0	0	0	31	0	0	304
112	37.2	115	303	33	451	29	3	0	0	32	0	0	483
113	36.1	25	15	11	51	0	0	2	0	2	0	0	53
114	27.6	15	0	20	35	0	0	0	0	0	0	0	35
115	26.3	1	0	0	1	0	0	0	0	0	0	0	1
116	36.0	0	0	32	32	0	0	0	0	0	0	0	32
117	29.1	0	0	0	0	0	0	2	50	52	0	0	52
118	35.9	0	0	61	61	0	0	35	30	65	0	0	126
119	34.0	0	0	350	350	0	0	0	0	0	0	0	350
120	47.3	0	0	1 021	1 021	0	0	1	15	16	0	0	1 037
Total	376.4	301	641	1 563	2 505	80	3	40	95	218	4	4	2 727

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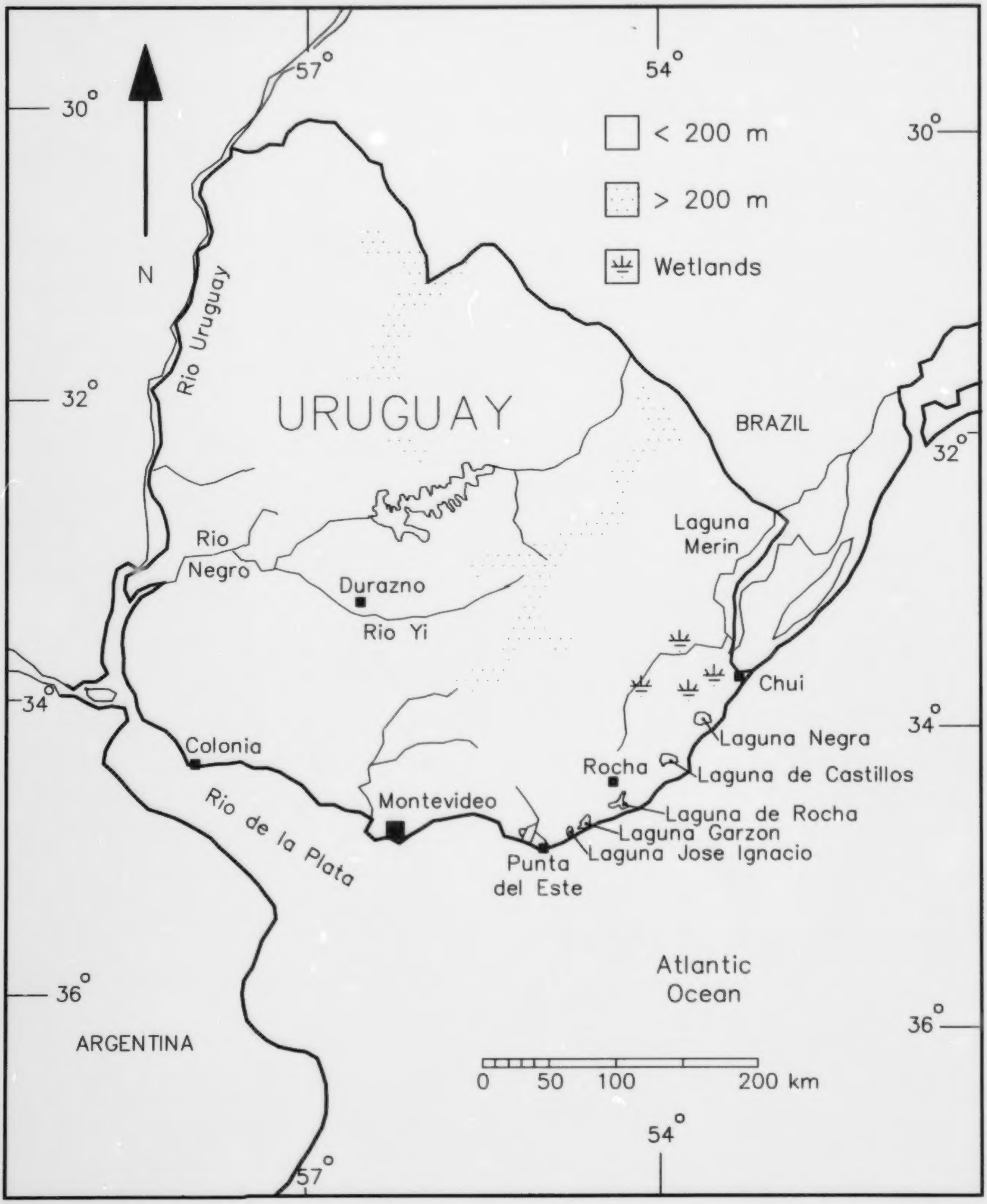
Figure 10.1
Some of the main geographical features of Uruguay


57°
54°
30°
30°
N
< 200 m
> 200 m
Wetlands
Rio Uruguay
URUGUAY
BRAZIL
32°
32°
Laguna Merin
Rio Negro
Durazno
Rio Yi
Chui
34°
34°
Laguna Negra
Colonia
Rocha
Laguna de Castillos
Montevideo
Laguna de Rocha
Laguna Garzon
Laguna Jose Ignacio
Punta del Este
Rio de la Plata
Atlantic Ocean
36°
36°
ARGENTINA
0
50
100
200 km
54°
57°

Chapter 10

Uruguay

R.I.G. Morrison, R.K. Ross, R. Vaz-Ferreira, and M. Huertas

10.1. General geography

Uruguay is situated approximately between 30 and 35°S and between 53 and 58°W, with coastlines on the north bank of the Rio de la Plata and South Atlantic Ocean (Fig. 10.1). Argentina lies to the south and west, with the Rio Uruguay forming the western border, and Brazil lies to the north. The surface area is some 176 215 km^2, and the coastlines of the Rio de la Plata and Atlantic Ocean are approximately 460 and 220 km long, respectively (Scott and Carbonell 1986). The climate of Uruguay is rather even, with monthly mean temperatures of 21-23°C between December and March. Mean minimum monthly temperatures from June to August vary in the range 11-13°C.

Geologically, Uruguay is situated along the southern border of the Brazilian Shield, and much of the coastline consists of long, sandy beaches interrupted periodically with rocky headlands. The southern part of the coast lies along the estuary of the Rio de la Plata. In terms of sediment deposition, the inner section of the estuary, including that between Colonia and about Montevideo, is dominated by fluvial influences, whereas the shorelines farther east and north are under both fluvial and marine influences. The deepest channels of the Rio de la Plata lie along the north side of the estuary and carry much of the water discharged from the river. Currents continue to flow outwards during much of the period of incoming tide, although at full tide the la Plata discharge is completely stopped near Montevideo. The relatively high-energy environment of the Uruguayan coast results in most of the onshore sediments being sandy, so that a rocky coast with sandy beaches is found. The sand is derived from the erosion of the coastal rocks and not from the Uruguay/Parana river system (Urien 1970). Sediments flowing down the main channel are discharged onto the adjoining continental shelf (Urien 1972) and have been transported northwards in earlier times as far as southern Brazil.

Of particular ornithological significance are the coastal lagoons occurring between Punta del Este and the border with Brazil (Fig. 10.1). The three lagoons between Punta del Este and Cabo Santa Maria (see Map 10.1) occupy former marine embayments in tectonic depressions that were closed by sand barriers during Pleistocene times (Jackson 1985). A Holocene outer barrier encloses the present lagoons (Jackson 1978). Rivers with variable, occasionally torrential, flow run along channels determined by fault lines into many of the lagoons.

10.2. Shorebird distribution

Moderate numbers of Nearctic shorebirds were found in Uruguay, the total of 10 500 representing 5.2% of the regional total for the Atlantic Coast (Table 10.1). Most of the Uruguayan total consisted of medium-sized species (7000, 66.2%; Table 10.2*b*), followed by small species (3100, 29.8%; Table 10.2*a*) and large species (420, 4.0%; Table 10.2*c*). Although Uruguayan totals were small in comparison with those for the continent, or even for the Atlantic Coast (Table 10.1), totals for individual species were in some cases the highest observed during the surveys. The 3200 Lesser Golden-Plovers *Pluvialis dominica*, for instance, made up 78.1% of the South American total (81.0% of the Atlantic Coast total), and the lagoons in which the birds were found were clearly the most important coastal habitats identified on the surveys, although for this species upland habitats are likely to be of greater overall importance. Uruguay also held regionally important numbers of Black-bellied Plovers *P. squatarola* (370, 58.7% of the Atlantic Coast total) and Ruddy Turnstones *Arenaria interpres* (250, 28.2% of the Atlantic Coast total). The majority of the birds were found in the coastal lagoons, with very few occurring along the ocean beaches.

10.3. Uruguay eco-unit

Sectors 1-20; Map 10.1 (Uruguay)

Some 76 km of the western shoreline of the Laguna Merin were surveyed in January 1986, from the mouth of the Rio Olimar to the southern end of the lagoon (Sectors 1 and 2; Table 10.4). This lagoon is separated from the ocean by a wide spit of Pleistocene origin: it contains fresh water, is up to 10 m deep, and covers some 330 000 ha (Jackson 1985; Scott and Carbonell 1986). The lagoon shoreline that was surveyed consisted mostly of firm sand or mud with relatively little emergent vegetation; low-lying marshy areas were common behind the beach and on the small points along the shore. Small numbers of Nearctic shorebirds were observed, the most notable sighting being of some 60 Hudsonian Godwits *Limosa haemastica* (Table 10.3), the most northerly observation made of this species during aerial surveys on the Atlantic side of the continent. The very extensive wetlands lying south of the lagoon and west of the border with Brazil (Sector 3, Banados del Este) contained relatively few Nearctic shorebirds, although moderately large numbers of waterfowl, particularly swans and tree ducks, were observed in the small area that was surveyed.

Table 10.1
Summary totals of Nearctic shorebirds in Uruguay

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Uruguay	621.9				
No. of birds		3 137	6 960	422	10 519
% Uruguayan total		29.8	66.2	4.0	100
% of size-class total (Atlantic Coast)		3.81	7.94	1.27	5.17
% of grand total (Atlantic Coast)		1.54	3.42	0.21	5.17
% of size-class total (South America)		0.13	1.52	0.35	0.36
% of grand total (South America)		0.11	0.24	0.01	0.36

Table 10.2*a*
Totals of Nearctic shorebird species in Uruguay—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	White-rumped Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Uruguay	621.9					
No. of birds		3	1	5	3 128	3 137
% of species total (Atlantic Coast)		12.00	0.0	0.05	4.43	3.81
% of size-class total (Atlantic Coast)		0.00	0.0	0.01	3.80	3.81
% of grand total (Atlantic Coast)		0.00	0.0	0.00	1.54	1.54
% of species total (South America)		0.70	0.04	0.00	0.14	0.13
% of size-class total (South America)		0.00	0.00	0.00	0.13	0.13
% of grand total (South America)		0.00	0.00	0.00	0.11	0.11

Table 10.2*b*
Totals of Nearctic shorebird species in Uruguay—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Uruguay	621.9						
No. of birds		3 167	365	253	88	3 087	6 960
% of species total (Atlantic Coast)		80.98	58.68	28.17	1.44	35.86	7.94
% of size-class total (Atlantic Coast)		3.61	0.42	0.29	0.10	3.52	7.94
% of grand total (Atlantic Coast)		1.56	0.18	0.12	0.04	1.52	3.42
% of species total (South America)		78.10	1.34	1.08	0.10	1.66	1.52
% of size-class total (South America)		0.69	0.08	0.06	0.02	0.68	1.52
% of grand total (South America)		0.11	0.01	0.01	0.00	0.11	0.24

Table 10.2*c*
Totals of Nearctic shorebird species in Uruguay—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds
Uruguay	621.9				
No. of birds		2	326	94	422
% of species total (Atlantic Coast)		0.95	1.00	59.49	1.27
% of size-class total (Atlantic Coast)		0.01	0.98	0.28	1.27
% of grand total (Atlantic Coast)		0.00	0.16	0.05	0.21
% of species total (South America)		0.01	0.72	1.44	0.35
% of size-class total (South America)		0.00	0.27	0.08	0.35
% of grand total (South America)		0.00	0.01	0.00	0.01

A long ocean beach runs south along the coast from Chui (Sector 4), backed by quartzose-calcareous dunes and the Pleistocene calcarenite ridges, which are part of the system enclosing the Laguna Merin (Jackson 1985). Although large numbers of gulls were seen, few Nearctic shorebirds were observed, apart from a few oystercatchers and a flock of 40 Lesser Golden-Plovers. South of La Coronilla, granitic rocks interrupt the beach to form a point and the offshore Coronilla Islands; 250 Ruddy Turnstones were observed in this area, along with moderate numbers of terns and cormorants.

Laguna Negra (Sector 5) contained relatively few Nearctic shorebirds: a few Lesser Golden-Plovers, yellowlegs, and peeps. It is a permanent lagoon up to 7 m deep, with poor drainage and a high accumulation of organic matter (Scott and Carbonell 1986). The shoreline is mostly sandy or muddy, and the lagoon is surrounded by marshes, pools, and seasonally flooded grassland and palm savannah.

The ocean beach between the Laguna Negra and the granitic headlands at Cabo Castillo and Cabo Polonio (Sector 6) again contained almost no Nearctic shorebirds, although gulls and oystercatchers were quite common.

The Laguna de Castillos (Sector 7) and associated wetlands between the lagoon and the ocean along the Arroyo Valizas (Sector 8) contained the second highest numbers of Nearctic shorebirds observed in Uruguay on the surveys. The lagoon is brackish and connected to the sea occasionally by a channel. Much of the shore is sandy, the lagoon being bordered by Holocene beaches some 2–4 m above sea level (Jackson 1985), and there are extensive marshes, pools, and seasonally flooded grassland and palm savannah, as well as dunes with scattered scrubby vegetation in the vicinity. Fifty Hudsonian Godwits were noted in the lagoon, along with several hundred peeps; Lesser Golden-Plovers were among the most common medium-sized species, 700 being observed in the wetlands near the lagoon in Sector 8. Large numbers of waterfowl, particularly swans and ducks, were found in the lagoon.

South of Cabo Polonio, a long ocean beach, backed by low dunes and terrain rolling back into grassland, runs southwestwards to Cabo Santa Maria (Sector 9). As with beaches elsewhere on the coast, Nearctic shorebirds were very uncommon, although oystercatchers and gulls were seen regularly. In Sector 9, only one small shorebird was observed in some 67 km of beach; between Cabo Santa Maria and the entrance to Laguna Garzon, only three Ruddy Turnstones and five Lesser Golden-Plovers were seen in some 29 km of beach.

The most important site identified in Uruguay for Nearctic shorebirds was the Laguna de Rocha (Sector 10), a large, shallow lagoon, up to 3 m deep, separated from the sea by a sand barrier, which is opened intermittently either naturally or artificially. As with the other lagoons between Cabo Santa Maria and Punta del Este, the Laguna de Rocha occupies a former marine embayment in a tectonic depression, which was enclosed by sand barriers in Pleistocene times, dissected during the glacial phase of low sea level, and enclosed by the present Holocene sand barrier (Jackson 1978, 1985). The Laguna de Rocha appeared shallower than some of the other lagoons; it had extensive muddy or sandy borders and was surrounded by areas of marshes and seasonally flooded grasslands and savannahs. The lagoon appeared to be highly productive. Over 7500 Nearctic shorebirds were counted on the lagoon, including 220 Hudsonian Godwits, 2800 peeps, and 4500 medium-sized shorebirds, which included 1700 Lesser Golden-Plovers, 370 Black-bellied Plovers, and over 70 yellowlegs (Table 10.3). The lagoon was also used by large numbers of waterfowl and other birds, including over 4000 swans (mostly Black-necked Swans *Cygnus melancoryphus*), 5000 gulls, and 1500 terns.

Smaller numbers of shorebirds were observed in the Laguna Garzon (Sector 12) and Laguna Jose Ignacio (Sector 13), with Lesser Golden-Plovers again making up the majority of the totals for the two areas (300 and 360 in totals of 590 and 410, respectively). Both lagoons are shallow and brackish, surrounded by marshes and grassland, and periodically connected to the sea via a sand barrier.

The Arroyo Maldonado (Sector 15) is a broad, shallow estuarine inlet/lagoon, with extensive sandy shoals surrounded by marshes. It has a permanent natural outlet over a granite substratum. The only Nearctic shorebirds observed during the surveys were some 70 Lesser Golden-Plovers.

Beaches between Punta del Este and Montevideo were not surveyed in January 1986 owing to very heavy use by humans and because so few shorebirds had been observed in similar habitats elsewhere along the coast. Coarse sand beaches are found in the coves between Punta del Este and the peninsular outcrops of Punta Ballena and Punta Negra to the west, whereas a fine sand beach backed by dune fields stretches from Punta Negra to Montevideo; some low cliffs and shore platforms occur around river mouths (Jackson 1985). Laguna del Sauce is a freshwater lake occupying a tectonic depression enclosed by dunes. Marshes, both fresh and salt, occur around the entrances of the Arroyo Solis Grande, Arroyo Pando, and Arroyo Tropa Vieja and are reported to be used by Neotropical shorebirds (Scott and Carbonell 1986), although they could not be covered during the present surveys.

No shorebirds were observed during surveys of the inner part of the estuary of the Rio de la Plata from the mouth of the Rio Santa Lucia near Montevideo eastwards to Punta Artilleros near Colonia (Sectors 16–20). Extensive riverine marshes are found around the mouth of the Rio Santa Lucia (Sector 16), whose course is determined by underlying faults, although the area is heavily affected by the proximity of Montevideo. To the west, the shoreline is almost entirely sandy. Cliffs occur behind the beach in the San Gregorio (Sector 17) and Mauricio (Sector 18) sections of the coast, where the shoreline is eroding; progradation of the coast takes place farther to the west around Arazati and the mouth of the Rio Rosario (Sectors 19 and 20). Marshy areas are found around the mouths of streams and rivers.

Map 10.1 (Uruguay)
Distribution of Nearctic shorebirds on the coast of Uruguay

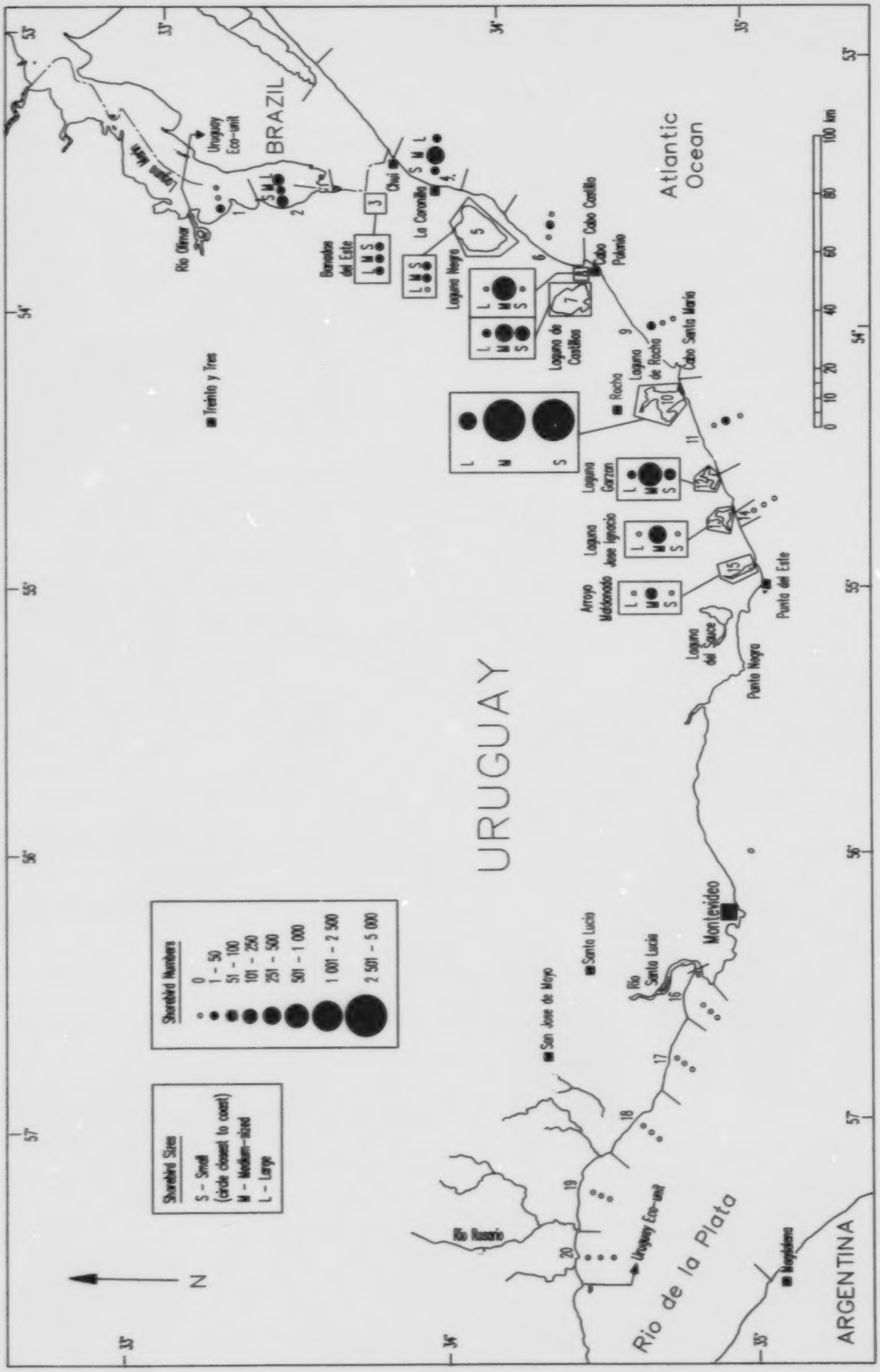

BRAZIL
URUGUAY
ARGENTINA
Atlantic Ocean
Rio de la Plata
Laguna Merin
Uruguay Eco-unit
Rio Olimar
Bañados del Este
Chuí
La Coronilla
Laguna Negra
Cabo Castillo
Cabo Polonio
Laguna de Castillos
Laguna de Rocha
Cabo Santa Maria
Rocha
Laguna Garzon
Laguna Jose Ignacio
Arroyo Maldonado
Punta del Este
Laguna del Sauce
Punta Negra
Treinta y Tres
Montevideo
Santa Lucia
Rio Santa Lucia
San Jose de Mayo
Rio Rosario
Uruguay Eco-unit
Magdalena
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
N
S M L
L M S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
33°
34°
35°
53°
54°
55°
56°
57°
0
10
20
40
60
80
100 km

Table 10.3
Totals of Nearctic shorebirds in survey sectors in Map 10.1 (Uruguay)

Sector no.	Sector length (km)	Spotted Sandpiper	White-rumped Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
1	33.7	0	0	0	14	14	0	0	0	0	0	0	0	0	0	0	14
2	42.4	3	1	0	74	78	2	0	0	1	5	8	0	61	0	61	147
3	50.3	0	0	0	1	1	0	0	0	0	5	5	0	0	30	30	36
4	29.7	0	0	5	0	5	41	0	250	0	0	291	1	0	0	1	297
5	46.8	0	0	0	7	7	12	0	0	4	1	17	0	0	0	0	24
6	33.7	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
7	39.5	0	0	0	220	220	0	0	0	0	430	430	0	50	0	50	700
8	7.7	0	0	0	0	0	700	0	0	1	2	703	0	0	0	0	703
9	67.4	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
10	52.9	0	0	0	2 751	2 751	1 680	365	0	74	2 381	4 500	1	215	42	258	7 509
11	28.7	0	0	0	0	0	5	0	3	0	0	8	0	0	0	0	8
12	25.3	0	0	0	60	60	295	0	0	3	213	511	0	0	22	22	593
13	14.8	0	0	0	0	0	358	0	0	5	50	413	0	0	0	0	413
14	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	26.0	0	0	0	0	0	73	0	0	0	0	73	0	0	0	0	73
16	17.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	26.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	26.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	33.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	19.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	621.9	3	1	5	3 128	3 137	3 167	365	253	88	3 087	6 960	2	326	94	422	10 519

Table 10.4
Principal habitats in survey sectors in Map 10.1 (Uruguay)

Sector no.	Habitat description
1	Freshwater lakeshore; some narrow sand and mud beach, several small river exits / marsh, grassland
2	Freshwater lakeshore; broad sand beach, marshy bay / grassland, farmland
3	Inland; system of marshy sloughs / grassland
4	Broad sand beach, rocky headlands and islands / grassland, some forest
5	Inland; freshwater lagoon with marshy sections, broad mud- and sandflats / grassland and small patches of trees
6	Broad steep sand beach / grasslands and small patches of forest
7	Inland; freshwater lagoon with alternating marshy and sandy shore / grassland
8	System of marshy sloughs / grassland, lagoon
9	Steep sand beach with some rocky points and islands offshore / rolling grassland, some patches of trees
10	Inland; shallow brackish lagoon with marshy shoreline, broad mud- and sandflats / grassland
11	Sand beach / band of forest, grassland
12	Inland; freshwater lagoon with sandy shores and some marsh / grassland
13	Inland; brackish lagoon with some mudflats / grassland
14	Sand beach / band of forest, grassland
15	Brackish estuary with mudflats and salt marsh / grassland
16	Narrow sand beach around river mouth / city
17	Sand beach / eroding cliffs / grassland, patches of trees
18	Sand beach, some marsh / vegetated dunes, some eroding cliffs / grassland, patches of trees
19	Sand beach, shoreline marsh / grasslands, some patches of trees, some ponds
20	Sand beach, shoreline marsh / band of forest, grasslands

10.4. Literature cited

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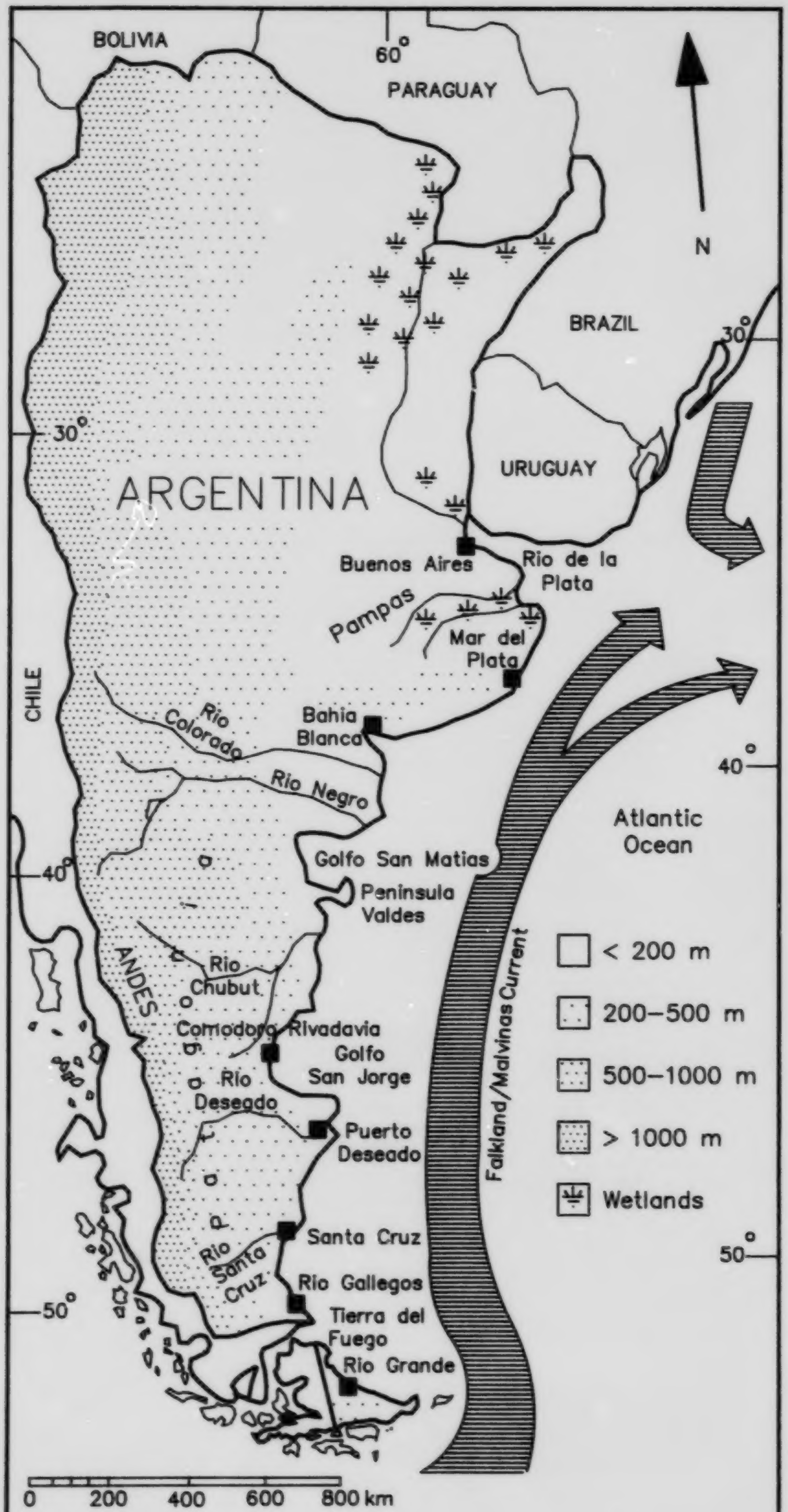
Figure 11.1
Some of the main geographical features of Argentina



BOLIVIA
PARAGUAY
N
BRAZIL
URUGUAY
CHILE
ARGENTINA
Buenos Aires
Rio de la Plata
Pampas
Mar del Plata
Bahia Blanca
Rio Colorado
Rio Negro
Golfo San Matias
Peninsula Valdes
ANDES
Rio Chubut
Comodoro Rivadavia
Golfo San Jorge
Rio Deseado
Puerto Deseado
Santa Cruz
Rio Santa Cruz
Rio Gallegos
Tierra del Fuego
Rio Grande
Atlantic Ocean
Falkland/Malvinas Current
< 200 m
200–500 m
500–1000 m
> 1000 m
Wetlands
0
200
400
600
800 km
30°
40°
50°
80°
70°
60°

Chapter 11

Argentina

R.I.G. Morrison, P. Canevari, and R.K. Ross

11.1. General geography

Argentina is the second largest country in South America, occupying much of the southern part of the continent east of the Andes (Fig. 11.1). It extends for some 5200 km between about 22 and 55°S, with climates varying from subtropical in the north to sub-Antarctic in the south. It has an area of some 2.8×10^6 km^2 and borders on Chile to the west, Bolivia and Paraguay to the north, and Brazil and Uruguay to the northeast.

The coastline of Argentina between the Rio de la Plata and Tierra del Fuego is some 5700 km long and contains a wide variety of habitats, the most distinctive of which include deltas, estuaries, boggy/marshy areas, sandy coasts with dunes, cliffs, beaches of rounded pebbles, and *restingas* (Schnack 1985). Offshore, the continental platform is very extensive, in some places 800 km in width. Tidal ranges are small in the north, less than 2 m, but are much larger along the coast of Patagonia, where maximum values of up to 9.45 m are reached. The coast may be divided into three major sections (Urien 1970), including the Pampas in the north, the Patagonian coast between the Rio Negro and Rio Gallegos, and the coast of Tierra del Fuego in the extreme south, each with a characteristic climate and flora. Brief descriptions are given below of the main geological and physiographic features, vegetation, and climate for these three regions.

11.2. The Pampas

11.2.1. Geology and topography

The Pampas plains are underlain by the Brazilian Platform, the basement of Precambrian rocks on which the entire Atlantic coast of South America between Bahia Blanca and the Orinoco River in Venezuela is situated (Almeida 1967; Almeida *et al.* 1973). The Precambrian rocks outcrop in the south-central and southern part of Buenos Aires province, forming the systems of the Sierra de Tandil and Sierra de Ventana. In general, however, the basement is covered by rocks of Paleozoic, lower Mesozoic, and upper Cenozoic age to depths of over 5000 m (Harrington 1956*a*, 1956*b*), over which a surface layer of Quaternary deposits has been formed, comprising the rich Quaternary loess and silts of the Pampas plains.

The Rio de la Plata marks the northern end of the Argentinian coast. The drainage basin of the Parana/Uruguay river system, which empties into it, is the second largest in South America after that of the Amazon, covering an area of some 3.17×10^6 km^2 (Urien 1972). The Rio Parana, which discharges into the Rio de la Plata, has formed a delta of some 15 000 km^2 and receives a continuous input of sediment of some 78.2×10^6 tons$\cdot$yr^{-1} (Urien 1972).

The coastline from the city of Buenos Aires to Punta Rasa is low-lying and marshy and is characterized by a vast plain of Holocene marine and estuarine sediments (Schnack 1985). Series of shell-strewn ridges running semiparallel to the coast indicate ancient shorelines. The enormous marshes and mudflats of Bahia Samborombon stretch between Punta Piedras and Cabo San Antonio. Major rivers entering the bay include the Rio Samborombon and Rio Salado, which drain the extensive Salado Basin occupying the centre of the province of Buenos Aires. Bahia Samborombon is very shallow, mostly less than 10 m in depth, with the inner parts only 2–5 m deep. The shallow depth provides protection from the action of waves and currents and results in conditions suitable for the deposition of fine sediments. It also restricts the entry of salt water, and salinities vary between 10 and 25 ppt (Urien 1972). The coastline of the bay is some 150 km long and consists of brackish, marshy wetlands varying between 0.5 and 6 km in width, alternating with grassy fields (Vervoorst 1967). Many small streams intersect the coast. The coastal wetlands form the breeding grounds of the small crab *Chasmognatus granulatus*. Tidal influences are strongly felt on the surrounding land owing to the extreme flatness of the coast (gradient 0.025%).

An open maritime coast of sand and dunes runs southwards from Punta Rasa, with elongated saline lagoons occurring behind the shore. Much of the area has been heavily modified by urbanization, and forestation schemes have been undertaken to stabilize the dunes and to create conditions appropriate for tourism, which is a very important industry in summer. The dune section ends around Laguna Mar Chiquita, a permanent, shallow coastal lagoon with a connection to the sea. The lagoon is some 5500 ha in area and contains muddy patches and banks as well as some brackish marshes with *Distichlis* spp. and stands of *Typha* spp. and *Scirpus* spp. (Scott and Carbonell 1986). Formation of the lagoon, which began some 5000 years ago when the sea was about 2.5 m higher, resulted from a southward prograding barrier shutting off an ancient estuary during a regression phase of the sea. Marine conditions prevail in the lower third of the lagoon, with 22–33 g salt per litre of water and a fauna of cirripedes, ctenophores, copepods, and marine species; at the upper end of the lagoon, the fauna is clearly freshwater (Ringuelet 1962).

The coastline south of Laguna Mar Chiquita consists mostly of cliffs and sand beaches. At Mar del Plata, there are rocky outcrops of early Paleozoic quartzites of the Tandil system. Loess and mud of Pleistocene age occur north and south of Mar del Plata, and the coastline is undergoing erosion, in places at a rate of 2–4 $m \cdot yr^{-1}$. The cliffs occurring between Mar del Plata and Bahia Blanca are generally 15–30 m high, reaching 35 m south of Mar del Plata, and run either along the coast or somewhat inland. For much of the south-facing part of the coast between the sierras of Tandil and Ventana, large dune fields have been built up along the shoreline. The dunes enclose elongated lagoons and are intersected by various streams, such as the Loberia and the Chapadmalal, and rivers, such as the Quequen Grande. Marine deposits of Holocene age are found between Monte Hermoso and the city of Bahia Blanca. The funnel-shaped Bahia Blanca contains various low-lying islands with poorly defined coastlines, and there are extensive intertidal flats and salt marshes.

Offshore environments are predominantly sandy between Cabo San Antonio and Bahia Blanca, and coastal sediments apparently result from the reworking of this material, as there is no significant supply from the rivers along the present shoreline (Urien and Ewing 1974). Beachrock is found along the ocean beaches east of Bahia Blanca.

11.2.2. Vegetation

The dominant vegetation of the Pampas region consists of steppe or pseudo-steppe grasses. Today, nearly all areas of natural habitat have been heavily modified, because the Pampas is the most important agricultural and grain-growing area in Argentina.

Scirpus californicus occurs along the shores of the Rio de la Plata, and forests of tala (*Celtis tala*) grow along the old shell-strewn beach ridges to approximately the city of Mar del Plata. In Bahia Samborombon, stands of *Spartina brasiliensis* are found on regularly inundated terrain, whereas *S. montevidensis* occurs on crab breeding grounds, which are occasionally flooded, together with *Salicornia ambigua*, *Scirpus americanus*, *S. californicus*, *Carex riparia*, and *Ipomoea bonariensis*. There are also stands of *Juncus acutus*, a sharp-leaved reed that grows in mats and forms pure populations (Cabrera 1976). In the coastal dunes south of Punta Rasa, the dominant plants are *Spartina ciliata*, a grass about 1 m in height, *Panicum racemosum*, and *Senecio crassiflorus*.

11.2.3. Climate

The climate is warm temperate. Rain occurs throughout the year, with peaks in spring and autumn, and there is a deficit of water during the summer. Annual rainfall decreases from the north to the south, from 1100 to 600 mm. Frost occurs during the winter and at the beginning of spring. Snow is rare in the extreme south during the winter and exceptional in the north (Cabrera 1976).

11.3. Patagonia

11.3.1. Geology and topography

The Patagonian sector of the Argentinian coast stretches from Bahia Blanca to Rio Gallegos in Santa Cruz province (Schnack 1985). The Patagonian landscape is characterized by extensive tablelands stretching between the Patagonian Cordillera section of the Andes and the Atlantic coast. This region, known as "Extra-Andean Patagonia," rises gradually from 800 m in the east to nearly 2000 m in the west. It is fairly uniform morphologically, but is divisible geologically into four subregions—the Patagonian and Deseado massifs and the Chubut and Santa Cruz depressions (Harrington 1956*a*, 1956*b*). The massifs are apparently not connected to the Brazilian Shield, and no evidence for a Precambrian craton related to the Brazilian Shield has been found south of 38°S (Zambrano and Urien 1974). Various geological basins occur along the coast, including the Colorado, San Jorge, Magellanes, and Valdes basins, which are filled with Cretaceous, Tertiary, and Quaternary sediments to an average depth of some 4 km (Urien and Zambrano 1973). Coastal plain complexes, such as the Bahia Blanca/Rio Colorado coastlines, form the surface expressions of the underlying basins (Urien and Ewing 1974).

The coastline is basically a continuation of the Patagonian terrace landscape, which was itself formed originally by successive tectonic movements (Cura 1958). It is characterized by a generally uniform physiography, climate, and vegetation, and there are extensive coastal cliffs composed of Tertiary deposits, both continental and marine, and volcanic rocks of Jurassic age. In some places, outcrops of erosion-resistant igneous rocks (porphyry, granite, and basalt) form promontories, such as those at Punta Tombo and in the areas of rocky capes between Cabo Raso and Cabo Aristizabal north of the Golfo San Jorge and around Punta Medanosa south of Rio Deseado. Gulfs and embayments are important coastal features, and the famous Patagonian or Tehuelche gravels occur in many places, particularly north and south of the Peninsula Valdes and in the southern part of the Golfo San Jorge, forming beaches along the shoreline. *Restingas* are found in many areas below such beaches; they are broad, wave-cut rocky platforms extending to the lower intertidal zone. Described by Murphy (1936) as "broadly plane, but very rough in detail," *restingas* are often covered with a rich invertebrate fauna and have many pools in which fishes and other marine life can survive between tides; they form an important habitat for many birds.

Wetlands and marshes are fairly restricted in occurrence and are usually found in protected, low-energy environments. In the southern part of the region, saline marshes are usually found in estuaries, which are often long and narrow, extending well inland from the coast where the major rivers have cut through the Patagonian plateau. Elsewhere, they may occur in protected areas, such as at Bahia Bustamante, behind the barrier inside the Caleta Valdes on the Peninsula Valdes, and within the embayment at San Antonio Oeste. Extensive intertidal areas and marshes are found in the estuaries and bays south of the Rio Colorado and at Bahia Blanca. The area between Bahia Blanca and the southern end of Bahia Union/Bahia Anegada forms a geomorphologically distinctive part of the coast of Patagonia. It consists of a narrow coastal plain forming the onshore portion of the Colorado Basin (Ewing *et al.* 1963) and may be differentiated from other areas by the presence of deltaic features, probably relict (Schnack 1985).

Some 18 000 years BP, the sea level was about 140 m lower than today, and the shoreline ran approximately along the border of what is now the submerged continental shelf. The sea level subsequently rose, covering the coastal plain and becoming stabilized, after some fluctuations, in its present position (Urien and Ewing 1974).

During this period, material brought down by the rivers was deposited within estuaries and then dispersed by longshore currents. The Colorado/Negro rivers spread their loads both southwards into what is now the Golfo San Matias, as well as northwards along the shores of Bahia San Blas and Bahia Blanca, with a narrow belt of muddy sand. It appears that the Patagonian rivers had a high load capacity during the Holocene, expelling a considerable sand stock onto the inner shelf, and probably being the main source of these sediments. Runoffs from the main rivers in the area are considerably smaller than that from the Rio de la Plata: runoff from the Rio Colorado is 180 $m^3 \cdot s^{-1}$ and from the Rio Negro 950 $m^3 \cdot s^{-1}$, compared with 23 000 $m^3 \cdot s^{-1}$ from the Rio de la Plata (Urien and Ewing 1974). Most discharged sediments appear to be trapped in the present estuarine systems, and the strong tidal offshore currents rework the sandy bottom.

11.3.2. Flora

A number of different phytogeographic provinces (Cabrera 1976) occur along the Patagonian coast. Summaries of the main types are given below, with emphasis on the coastal areas.

11.3.2.1. Province of Espinal

The area between Bahia Blanca and the Rio Negro forms part of the Calden district of the phytogeographic province of Espinal. The calden (*Prosopis caldenia*) is a xerophytic tree that grows up to 10 m high and forms small fairly open wooded areas with a herbaceous strata rich in grasses. Intertidal areas in Bahia Blanca and Bahia Anegada are similar to those in Bahia Samborombon. Dominant species in the tidal channels of Bahia San Blas and at the mouths of the Rio Colorado and Rio Negro are the grasses *Spartina montevidensis* and *S. brasiliensis* (Hauman-Merck 1913). *Spartina montevidensis* is found in areas submerged only by the highest tides, whereas *S. brasiliensis* grows in areas that are flooded daily; this species also grows on the beaches north of Bahia Blanca. *Juncus acutus* is also found bordering brackish channels in Bahia San Blas (Hauman-Merck 1913).

Matero or Palo Azul (*Cyclolepis genistoides*), a shrub of some 2 m in height, grows on the very alkaline soils found on the islands and islets in the region. Other common species include *Atriplex undulata*, *Distichlis spicata*, *Salicornia ambigua*, and *Psila spartioides*.

11.3.2.2. Province of Monte

The phytogeographic province of Monte extends from the Rio Negro to Punta Lobos, a little north of Punta Tombo, excluding the Peninsula Valdes, which possesses a Patagonian flora. It is dominated by a steppe of shrubby xerophytes, sammophytes, and halophytes of 1–2 m in height. Dominant species include *Larrea* spp., *Bougainvillea spinosa*, and *Condalia microphylla*.

The soils are heavily leached, sandy, deep, and very permeable (Cabrera 1976). The most abundant plants are those that are spiny or have reduced leaves, ephemeral plants, geophytes with subterranean organs that hold water, and succulents. In the coastal dunes, *Hyalis argentea* and *Sporobolus arundinaceus* are dominant.

11.3.2.3. Patagonian province*

The Patagonian province extends from Punta Lobos to Estancia Viamonte in the centre of Tierra del Fuego and includes the Peninsula Valdes. It is dominated by a steppe of shrubs, water-storing plants, and herbs, all of which show adaptations to wind and herbivores. Abundant plants include those showing protective adaptations, such as development of thorns or resinous or waxy skins or growth in cushions.

Various districts and subdistricts (Soriano 1956; Cabrera 1976) may be distinguished, and those that have coastal areas are described in the following section.

11.3.2.3.1. Central district

The Chubut subdistrict includes the coast between Punta Lobos and Cabo Raso as well as the Peninsula Valdes. Shrubby steppes with quilembai (*Chuquiraga avellanedae*), colapiche (*Nassauvia glomerulosa*), and distinct species of *Stipa* are found near the sea. *Atriplex* spp. and *Suaeda divaricata* are found in brackish situations along the shoreline, and *Salicornia ambigua* is found on barrier beaches flooded occasionally by the tide.

The Santa Cruz subdistrict extends from Bahia Mazarredo to Monte Leon, just south of Rio Santa Cruz. The vegetation is very similar to that of the Chubut subdistrict, with the quilembai being replaced by the mata negra (*Verbena tridens*). *Salicornia ambigua*, *Atriplex reichei*, and *A. sagittifolium* are found in brackish coastal areas.

11.3.2.3.2. District of Golfo San Jorge

This area extends from Cabo Raso to Bahia Mazarredo. Shrubby and herbaceous steppe vegetation predominates on the rocky soil, which is poor in organic material. Dominant plants are duraznillo (*Coliguaya integerrima*) and malaspina (*Trevoa patagonica*), accompanied by species of *Poa*, *Stipa*, and *Festuca*. As in the Central district, these plants occur near the sea. *Salicornia ambigua*, *Atriplex reichei*, *A. sagittifolia*, *Frankenia microphylla*, *Suaedea divaricata*, and other plants are found on low-lying brackish ground near the coast (Soriano 1956; Cabrera 1976).

11.3.3. Climate

Considerable variation occurs in the climate along the coast of Patagonia, as might be anticipated from its length. In the southern part of Buenos Aires province, the climate is temperate and dry, with rain occurring principally during the summer (Cabrera 1976). In most of this province, the moisture that produces rainfall comes from the Atlantic Ocean; from approximately Bahia Blanca southwards, however, such moisture comes from the Pacific Ocean (Chiozza and van Domselaar 1958). The transition zone occurs in the southern sector of Buenos Aires province. The prevailing westerly winds discharge most of their precipitation in the Andes and arrive dry on the Patagonian steppes. Rainfall decreases from north to south: mean annual precipitation at Bahia Blanca is 558 mm, whereas in Carmen de Patagones it is 383 mm.

There is little or no noticeable oceanic influence on the climate along the coast of Patagonia, perhaps due to the height of the Patagonian plateau, the prevailing winds from the west, and the cold Falkland (Malvinas) Current running northwards along the shore (Chiozza and van

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* See also Section 11.4.2.1.

Bahia San Sebastian, Tierra del Fuego, Argentina. Huge intertidal mudflats have built up in Bahia San Sebastian behind a protective spit some 18 km in length on the Atlantic coast of Tierra del Fuego; the area was the most important coastal wintering site for Hudsonian Godwits discovered during the surveys.

Domselaar 1958). The climate is cold, arid, or semiarid, with scanty precipitation and fierce westerly winds. The temperature declines southwards along the coast, but the duration of daylight during the summer months increases. Cloudiness increases southwards to a maximum in Santa Cruz. During the winter, snow is abundant in the south.

11.4. Tierra del Fuego

11.4.1. Geology and topography

The continental coast south of Rio Gallegos is characterized by the presence of Quaternary glacial deposits very similar to those of Tierra del Fuego (Schnack 1985). Glaciers covered the area until some 16 000 years ago, when they commenced to recede, a process that is still continuing. Tierra del Fuego was joined to the continent until some 10 000 years ago.

The northern part of the island is undulating and open, with grassy steppe vegetation. Sand, gravel, and clay were deposited on the Tertiary sediments covering it during the recession of the glaciers in the Quaternary. Cliffs often run along the edge of the grassy tableland at the coast, and pebble beaches are common. Vast intertidal mudflats occur in Bahia San Sebastian, which is enclosed by Punta Paramo, a pebble barrier spit some 18 km long. To the south, the coast is predominantly rocky, sections of cliffs and headlands alternating with grassy tablelands, and there are wide expanses of *restinga* backed by gravel beaches running along the shore. Exposed materials include Quaternary glacigenic or marine deposits, Tertiary sediments, and Mesozoic marine and volcanic rocks. Tablelands in the southern sector of the coast are covered with forests of austral beech (*Nothofagus* spp.) and bogs.

11.4.2. Flora

11.4.2.1. Patagonian province*

11.4.2.1.1. Sub-Andean district

The Sub-Andean district extends from Monte Leon to Cabo Virgenes at the eastern mouth of the Strait of Magellan. The soils are rich in fine material and have much organic matter. The area is made up of a grassy steppe dominated by coiron blanco (*Festuca pallescens*), a caespitose grass 20–60 cm high (Soriano 1956). *Senecio patagonicus* and *Plantago maritima* are found in coastal dunes, with *Azorella monantha*, *Hordeum jubatum*, *Adesmia lanata*, and other plants (Cabrera 1976). In salty soils near the sea, *Lepidophyllum cupressiforme* is dominant, together with *Atriplex reichei*; *Salicornia ambigua* and *Suaeda fruticosa* are also common.

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* See also Section 11.3.2.3.

11.4.2.1.2. Fuegian district

This district extends from the north of Tierra del Fuego to Estancia Viamonte, south of Rio Grande, where forests of austral beech (*Nothofagus* spp.) commence. The soils are totally sandy or sandy with a high content of organic material. The steppes are dominated by coiron fueguino (*Festuca gracillima*), producing a smoothly undulating landscape. In the extreme north, the shrub *Lepidophyllum cupressiforme* may dominate sandy patches along the shore and also grows on interior dunes. In saline situations near or below the tide line, the dominant is *Salicornia ambigua*, a fleshy plant of a few centimetres in height forming pure stands. *Plantago barbata*, *P. maritima*, *Suaeda argentinensis*, and other plants are found growing along channels on the shore (Moore 1983).

Other sandy coasts may have almost pure communities of *Senecio candidans*, with or without *Acaena magellanica*, *Rumex magellanica*, and *Adesmia pumila* (Moore 1983). *Apium australe*, *Colobanthus quitensis*, *C. subulatus*, *Plantago barbata*, *P. maritima*, and other plants are found on rocky or sandy coasts (Moore 1983).

11.4.2.2. Sub-Antarctic province

11.4.2.2.1. Magellanic district

This district covers the south-central portion of Tierra del Fuego. It is strongly undulating in the north and mountainous in the south. The region is covered by forests of several distinct species of austral beech (*Nothofagus betuloides*, *N. pumilio*, *N. antarctica*) and by abundant peat bogs. The forests in many places extend right to the coast, where beeches are joined by other species such as *Drimys winteri* and shrubs such as *Fuchsia magellanica*, *Ribes magellanica*, and *Pernettya mucronata*. In more exposed situations, shrubs grow up to about 1 m in height, including *Hebe elliptica*, *Berberis illicifolia*, *Empetrum rubrum*, and *Escallonia serreta*. Communities similar to those of sandy coasts in the Fuegian district are found, with *Senecio candidans*, *Acaena magellanica*, *Rumex magellanica*, *Adesmia pumila*, *Apium australe*, and *Poa robusta*. These plants are also found on rocky coasts, with *Abrotanella submarginata* and *Poa darwiniana* (Moore 1983).

11.4.3. Climate

Precipitation increases southwards through the region (222 mm in Rio Gallegos, 370 mm in Rio Grande, and 545 mm in Ushuaia), owing to the almost peninsular characteristics of the mainland south of Santa Cruz and to the insular characteristics of Tierra del Fuego itself. In addition, the lower Andean valleys permit the passage of winds with greater water content than those to the north. Although temperatures are lower than farther north, the greater humidity reduces the range of temperature. Mean temperatures for summer are similar to or lower than those for winter in the province of Buenos Aires. In Rio Grande, it can snow from March to December.

Winds are predominantly from the west, southwest, and northwest and can reach hurricane force, principally in the summer and during the afternoon (Chiozza and van Domselaar 1958). In south-central Tierra del Fuego, winds are calmer, although the weather is normally bad and the sky is almost permanently covered by cloud.

11.5. Shorebird distribution

The total of more than 92 600 shorebirds counted during surveys in Argentina included 41 400 (44.7%) small shorebirds, 30 200 (32.6%) medium-sized shorebirds, and 20 800 (22.5%) large shorebirds, with a further 190 birds (0.2%) not categorized by size (Table 11.1). The overall total represented 3.2% of the South American grand total, with totals for the small, medium-sized, and large categories representing 1.8, 6.6, and 17.2% of the respective size-class totals for the continent. Argentina was very important regionally, however, the survey totals representing 50.3, 34.4, and 62.7% of the Atlantic Coast totals for small, medium-sized, and large shorebirds (overall 45.5%), respectively. At the species level, areas of major international importance were found along the coastlines of Patagonia and Tierra del Fuego, especially for Red Knots *Calidris canutus* and Hudsonian Godwits *Limosa haemastica* (see below).

The majority of the 39 600 small sandpipers found on coastal habitats in Argentina were White-rumped Sandpipers *Calidris fuscicollis*, and the total represented 56.0% of the Atlantic Coast total for this category (Table 11.2*a*). The largest concentrations were found in Tierra del Fuego, especially near Bahia San Sebastian and along the Atlantic coast, with the Tierra del Fuego eco-unit total of 23 300 representing 32.9% of the Argentinian total or 28.2% of the Atlantic Coast total. Other important areas for small shorebirds were found in the Golfo San Jorge eco-unit, especially around Caleta Olivia south of Commodoro Rivadavia, and in the Rio Colorado eco-unit, in the large estuarine areas of Bahia Anegada and Bahia Union. The Argentinian total of 1800 Sanderlings *Calidris alba* represented 19.9% of the Atlantic Coast total, the majority being found around the Peninsula Valdes, along the coast of Tierra del Fuego, and along the beaches of Buenos Aires province.

Nearly 24 800 Red Knots were counted in Argentina, representing 32.4% of the South American total (Table 11.2*b*). The most important areas were in Tierra del Fuego, along the *restingas* on the Atlantic coast, and around Bahia San Sebastian; other important areas occurred in the Golfo San Jorge eco-unit, particularly around Bahia Bustamante and on the *restingas* between Caleta Olivia and Cabo Blanco, as well as around the Peninsula Valdes. Yellowlegs *Tringa* spp. were noted as far south as the Golfo San Jorge eco-unit, although most (650) of the 720 birds counted in Argentina occurred in Buenos Aires province, principally on the marshes around Bahia Samborombon and at Laguna Mar Chiquita. Ruddy Turnstones *Arenaria interpres* did not appear to be common, with flocks being noted only in the Golfo San Jorge, and a single bird near the southern tip of Tierra del Fuego. Lesser Golden-Plovers *Pluvialis dominica* were observed in Buenos Aires province as far south as Bahia Blanca.

The most important coastal wintering areas discovered in South America for the Hudsonian Godwit were in Tierra del Fuego. The single most important site was Bahia San Sebastian, where 19 400 godwits were counted, representing 42.6% of the South American total (Table 11.2*c*). This concentration represented 93.6% of the Argentinian total or 59.3% of the birds counted on the Atlantic coast. The second most important site in South America, Bahia Lomas, is only some 60 km to the north in the Chilean sector of Tierra del Fuego; Bahia Lomas held 10 500 godwits, a further 23.1% of the South American total, attesting to

Table 11.1
Summary totals of Nearctic shorebird species in eco-units in Argentina

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Unclassified shorebirds	Total shorebirds
Buenos Aires	921.8					
No. of birds		1 625	1 994	482	103	4 204
% of size-class total (Argentina)		3.92	6.60	2.32	53.09	4.54
% of size-class total (South America)		0.07	0.44	0.40	0.79	0.14
% of size-class total (Atlantic Coast)		1.97	2.27	1.45	53.09	2.07
% of grand total (Atlantic Coast)		0.80	0.98	0.24	0.05	2.07
Rio Colorado	910.5					
No. of birds		4 967	1 846	318	0	7 131
% of size-class total (Argentina)		11.99	6.11	1.53	0.00	7.70
% of size-class total (South America)		0.21	0.40	0.26	0.00	0.24
% of size-class total (Atlantic Coast)		6.03	2.11	0.96	0.00	3.51
% of grand total (Atlantic Coast)		2.44	0.91	0.16	0.00	3.51
Peninsula Valdes	784.9					
No. of birds		1 815	5 086	0	1	6 902
% of size-class total (Argentina)		4.38	16.84	0.00	0.52	7.45
% of size-class total (South America)		0.08	1.11	0.00	0.01	0.24
% of size-class total (Atlantic Coast)		2.20	5.80	0.00	0.52	3.39
% of grand total (Atlantic Coast)		0.89	2.50	0.00	0.00	3.39
Golfo San Jorge	730.9					
No. of birds		7 559	9 128	357	90	17 134
% of size-class total (Argentina)		18.24	30.23	17.16	46.39	18.50
% of size-class total (South America)		0.32	2.00	0.29	0.69	0.59
% of size-class total (Atlantic Coast)		9.18	10.41	1.08	46.39	8.42
% of grand total (Atlantic Coast)		3.72	4.49	0.18	0.04	8.42
Rio Gallegos	770.9					
No. of birds		1 700	550	163	0	2 413
% of size-class total (Argentina)		4.10	1.82	0.78	0.00	2.61
% of size-class total (South America)		0.07	0.12	0.13	0.00	0.08
% of size-class total (Atlantic Coast)		2.06	0.63	0.49	0.00	1.19
% of grand total (Atlantic Coast)		0.84	0.27	0.08	0.00	1.19
Tierra del Fuego	430.0					
No. of birds		23 763	11 591	19 486	0	54 840
% of size-class total (Argentina)		57.36	38.39	93.66	0.00	59.21
% of size-class total (South America)		1.02	2.54	16.06	0.00	1.88
% of size-class total (Atlantic Coast)		28.85	13.22	58.77	0.00	26.96
% of grand total (Atlantic Coast)		11.68	5.70	9.58	0.00	26.96
All Argentina	4 549.0					
No. of birds		41 429	30 195	20 806	194	92 624
% of size-class total (Atlantic Coast)		50.30	34.43	62.75	100	45.54
% of size-class total (South America)		1.78	6.61	17.15	1.48	3.17
% of grand total (South America)		1.42	1.03	0.71	0.01	3.17

the enormous importance of Tierra del Fuego as a wintering area. Smaller numbers of Hudsonian Godwits were found along the *restingas* on the Atlantic coast of Argentinian Tierra del Fuego. This habitat was also used by the smaller concentrations of godwits that were found elsewhere on the coast of Patagonia, particularly along the southern part of the Golfo San Jorge near Caleta Olivia, and near Puerto Deseado. Farther north on the coast, moderate concentrations (310) were found on the extensive intertidal flats of Bahia Union and Bahia Anegada south of the exit of the Rio Colorado, and on the marshes and flats along the southern portion of Bahia Samborombon in Buenos Aires province.

11.6. Buenos Aires eco-unit

Sectors 1–22; Maps 11.1 (Argentina-1) to 11.4 (Argentina-4)

The Buenos Aires eco-unit covers the Pampas coastline of Buenos Aires province, from the city of Buenos Aires to Bahia Blanca. The eco-unit may be divided into two zones—the estuarine and marshy coastlines of the Rio de la Plata and Bahia Samborombon, and the sandy coastline from Punta Rasa to Bahia Blanca.

11.6.1. Rio de la Plata estuary and Bahia Samborombon

Sectors 1–6; Maps 11.1 (Argentina-1) and 11.2 (Argentina-2)

The estuary of the Rio de la Plata, and more particularly Bahia Samborombon at its southern end, contains important habitat for shorebirds. The Rio de la Plata receives drainage from the vast Parana/Uruguay river systems, which originate in the Sierra do Mar and Mato Grosso plateau (200–700 m altitude) in Brazil, and in the Sub-Andean ranges in northwest Argentina and southern Bolivia (3500–4000 m altitude). The Rio de la Plata estuary itself covers an area of some 35 000 km^2, being 270 km long and varying in width from 32 to 230 km at its outer boundary (Urien 1972). It lies along the southern border of the Brazilian Shield on the Uruguayan side and north of the Salado Basin on the Argentinian side, its position resulting from tectonic activity in Tertiary and Quaternary times. The two enclosing coastlines are thus rather different, with a rocky coast containing sandy beaches along the Uruguayan side, and a coastline covered by Quaternary loess sediments on the Argentinian side, to which modern sediments are being added. Modern deposits involve clay to silty clays and sand in Bahia Samborombon and on beaches, and sand to silty sand on the Parana delta shore in

Table 11.2a
Totals of Nearctic shorebird species in eco-units in Argentina—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds
Buenos Aires	921.8			
No. of birds		253	1 372	1 625
% of species total (Atlantic Coast)		2.73	1.94	1.97
% of species total (South America)		0.23	0.06	0.07
% of size-class total (Atlantic Coast)		0.31	1.67	1.97
% of grand total (Atlantic Coast)		0.12	0.67	0.80
Rio Colorado	910.5			
No. of birds		240	4 727	4 967
% of species total (Atlantic Coast)		2.59	6.69	6.03
% of species total (South America)		0.21	0.21	0.21
% of size-class total (Atlantic Coast)		0.29	5.74	6.03
% of grand total (Atlantic Coast)		0.12	2.32	2.44
Peninsula Valdes	784.9			
No. of birds		777	1 038	1 815
% of species total (Atlantic Coast)		8.37	1.47	2.20
% of species total (South America)		0.69	0.05	0.08
% of size-class total (Atlantic Coast)		0.94	1.26	2.20
% of grand total (Atlantic Coast)		0.38	0.51	0.89
Golfo San Jorge	730.9			
No. of birds		75	7 484	7 559
% of species total (Atlantic Coast)		0.81	10.59	9.18
% of species total (South America)		0.07	0.34	0.32
% of size-class total (Atlantic Coast)		0.09	9.09	9.18
% of grand total (Atlantic Coast)		0.04	3.68	3.72
Rio Gallegos	770.9			
No. of birds		0	1 700	1 700
% of species total (Atlantic Coast)		0.00	2.41	2.06
% of species total (South America)		0.00	0.08	0.07
% of size-class total (Atlantic Coast)		0.00	2.06	2.06
% of grand total (Atlantic Coast)		0.00	0.84	0.84
Tierra del Fuego	430.0			
No. of birds		504	23 259	23 763
% of species total (Atlantic Coast)		5.43	32.92	28.85
% of species total (South America)		0.45	1.05	1.02
% of size-class total (Atlantic Coast)		0.61	28.24	28.85
% of grand total (Atlantic Coast)		0.25	11.43	11.68
All Argentina	4 549.0			
No. of birds		1 849	39 580	41 429
% of species total (South America)		1.65	1.79	1.78
% of size-class total (South America)		0.08	1.70	1.78
% of grand total (South America)		0.06	1.36	1.42

the upper estuary (Urien 1972), where the delta is growing by about 1.6 km · yr^{-1} (Urien and Ewing 1974). Modern materials date from some 3000 years BP and result from deposition after the present sea level was established, whereas some of the older sands of the coastal plain result from the Holocene transgression of the sea and have been dated at about 6000–11 000 years BP (Urien 1972).

The Rio de la Plata estuary may be divided into several zones in terms of sediment deposition: the modern delta plain, an inner section under fluvial control, a fluviomarine area where freshwater and marine influences interact, and an outer marine-dominated zone (Urien 1972). The Rio Parana discharges some 547 600 × 10^6 $m^3 \cdot yr^{-1}$ of water and the Rio Uruguay some 132 800 × 10^6 $m^3 \cdot yr^{-1}$ (Tossini 1959; Urien 1972). The bulk of the average suspended sediment load of 79.8 × 10^6 tons · yr^{-1} delivered by the rivers comes from the Rio Parana complex (72.8 × 10^6 tons · yr^{-1}; Urien 1972).

The deepest channels are on the north side of the estuary and carry much of the water in the inner estuary. The tidal range is somewhat higher on the Argentinian side than on the Uruguayan coast because the incoming currents are deflected southwards under the influence of the Coriolis force (Balay 1961): tidal range is 0.8 m at Buenos Aires and 1.1 m at Cabo San Antonio in Argentina, and 0.6 m at both Colonia and Montevideo in Uruguay (Urien 1972). A residual tidal counterclockwise circulation develops in Bahia Samborombon, flowing seaward with discharged river sediments. Bahia Samborombon, which lies between Punta Piedras, a Pleistocene wave-cut platform, in the north, and Punta Rasa, a sandy spit, in the south, is very shallow, much of it being less than 10 m deep and in the inner parts only 2–5 m. This protects it from wave and current action, and high waves do not generally occur in the bay (Urien 1972). The combination of a low-energy environment and prevailing current patterns results in conditions favourable for the deposition of finer sediments. The shallowness also restricts the entry of salt water, and salinities vary in the range 10–25 ppt (Urien 1972).

On the northern side of the estuary, currents continue to flow out of the north channel for much of the period of incoming tide, although at full tide the Rio de la Plata discharge is completely stopped across a line running approximately from Punta Piedras to Montevideo (Urien 1972). The higher-energy environment of the Uruguayan coast results in most of the onshore coastal sediments being sandy, so that a rocky coast with sandy beaches is found. The sand is derived from the erosion of the coastal rocks and not from the Uruguay/Parana river system (Urien

Table 11.2b
Totals of Nearctic shorebird species in eco-units in Argentina—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Buenos Aires	921.8							
No. of birds		85	0	0	642	0	1 267	1 994
% of species total (Atlantic Coast)		2.17	0.00	0.00	10.52	0.00	14.72	2.27
% of species total (South America)		2.10	0.00	0.00	0.70	0.00	0.68	0.44
% of size-class total (Atlantic Coast)		0.10	0.00	0.00	0.73	0.00	1.44	2.27
% of grand total (Atlantic Coast)		0.04	0.00	0.00	0.32	0.00	0.62	0.98
Rio Colorado	910.5							
No. of birds		30	5	0	1	50	1 760	1 846
% of species total (Atlantic Coast)		0.77	0.80	0.00	0.02	0.07	20.45	2.11
% of species total (South America)		0.74	0.02	0.00	0.00	0.07	0.95	0.40
% of size-class total (Atlantic Coast)		0.03	0.01	0.00	0.00	0.06	2.01	2.11
% of grand total (Atlantic Coast)		0.01	0.00	0.00	0.00	0.02	0.87	0.91
Peninsula Valdes	784.9							
No. of birds		0	5	0	55	5 023	3	5 086
% of species total (Atlantic Coast)		0.00	0.80	0.00	0.90	7.44	0.03	5.80
% of species total (South America)		0.00	0.02	0.00	0.06	6.58	0.00	1.11
% of size-class total (Atlantic Coast)		0.00	0.01	0.00	0.06	5.73	0.00	5.80
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.03	2.47	0.00	2.50
Golfo San Jorge	730.9							
No. of birds		0	0	320	17	8 691	100	9 128
% of species total (Atlantic Coast)		0.00	0.00	35.63	0.28	12.87	1.16	10.41
% of species total (South America)		0.00	0.00	1.36	0.02	11.38	0.05	2.00
% of size-class total (Atlantic Coast)		0.00	0.00	0.36	0.02	9.91	0.11	10.41
% of grand total (Atlantic Coast)		0.00	0.00	0.16	0.01	4.27	0.05	4.49
Rio Gallegos	770.9							
No. of birds		0	0	0	0	550	0	550
% of species total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.81	0.00	0.63
% of species total (South America)		0.00	0.00	0.00	0.00	0.72	0.00	0.12
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.63	0.00	0.63
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.27	0.00	0.27
Tierra del Fuego	430.0							
No. of birds		0	0	1	0	10 470	1 120	11 591
% of species total (Atlantic Coast)		0.00	0.00	0.11	0.00	15.50	13.01	13.22
% of species total (South America)		0.00	0.00	0.00	0.00	13.71	0.60	2.54
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	11.94	1.28	13.22
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	5.15	0.55	5.70
All Argentina	4 549.0							
No. of birds		115	10	321	715	24 784	4 250	30 195
% of species total (South America)		2.84	0.04	1.37	0.78	32.44	2.29	6.61
% of size-class total (South America)		0.03	0.00	0.07	0.16	5.42	0.93	6.61
% of grand total (South America)		0.00	0.00	0.01	0.02	0.85	0.15	1.03

1972). Sediments flowing down the main channel are discharged into the adjoining continental shelf (Urien 1972) and have been transported northwards in earlier times as far as southern Brazil.

The southern bank of the Rio de la Plata (Sectors 1–3) between Buenos Aires and Punta Piedras consists mostly of sandy and silty mudbanks backed by marshy areas and scrubby grassland and farmland (Table 11.4). No shorebirds were seen in the innermost section (Sector 1), although numbers increased somewhat towards Punta Piedras, with peeps, Lesser Golden-Plovers, and yellowlegs being the most common shorebirds observed (Table 11.3).

Moderate concentrations of shorebirds were found on the enormous mudflats and marshes of Bahia Samborombon (Sectors 3–6; Tables 11.3–11.6), numbers increasing somewhat in the central and southern sections of the bay. Medium-sized species were most numerous, with yellowlegs being the most commonly identified species; flocks of up to several hundred peeps were scattered along the shore. Very large expanses of smooth or corrugated silty flats were exposed during the surveys, leading to wide salt marshes backed by flat agricultural pampas. The southern part of the bay immediately west of Punta Rasa was notable for moderate concentrations of Hudsonian Godwits (420); extensive marshes and reedbeds are found behind the shore between Punta Rasa and Campos del Tuyu north of General Lavalle around the mouth of the Rio Ajo; this area is thought to be of considerable importance for Hudsonian Godwits and Red Knots during migration, with reported concentrations of up to 3000 godwits (M. Nores, pers. commun.; Morrison 1984).

It is likely that Bahia Samborombon is of considerably greater importance than indicated by the survey totals because our survey flights took place at low tide.

11.6.2. Punta Rasa to Bahia Blanca

Sectors 6–22; Maps 11.2 (Argentina-2) to 11.4 (Argentina-4)

The shoreline between Punta Rasa and Bahia Blanca is very sandy, consisting mostly of long ocean beaches. The sands found along the coast of Buenos Aires province south of Punta Rasa are very similar to those on the neighbouring Argentinian continental shelf (Teruggi *et al.* 1959) and were apparently deposited after transgression by the sea (Urien 1972). These sands are very similar to the relict sand and shell sediments that form the bottom

Table 11.2c
Totals of Nearctic shorebird species in eco-units in Argentina—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds
Buenos Aires	921.8				
No. of birds		6	429	47	482
% of species total (Atlantic Coast)		2.86	1.31	29.75	1.45
% of species total (South America)		0.02	0.94	0.72	0.40
% of size-class total (Atlantic Coast)		0.02	1.29	0.14	1.45
% of grand total (Atlantic Coast)		0.00	0.21	0.02	0.24
Rio Colorado	910.5				
No. of birds		0	313	5	318
% of species total (Atlantic Coast)		0.00	0.96	3.16	0.96
% of species total (South America)		0.00	0.69	0.08	0.26
% of size-class total (Atlantic Coast)		0.00	0.94	0.02	0.96
% of grand total (Atlantic Coast)		0.00	0.15	0.00	0.16
Peninsula Valdes	784.9				
No. of birds		0	0	0	0
% of species total (Atlantic Coast)		0.00	0.00	0.00	0.00
% of species total (South America)		0.00	0.00	0.00	0.00
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00
Golfo San Jorge	730.9				
No. of birds		0	352	5	357
% of species total (Atlantic Coast)		0.00	1.08	3.16	1.08
% of species total (South America)		0.00	0.77	0.08	0.29
% of size-class total (Atlantic Coast)		0.00	1.06	0.02	1.08
% of grand total (Atlantic Coast)		0.00	0.17	0.00	0.18
Rio Gallegos	770.9				
No. of birds		0	160	3	163
% of species total (Atlantic Coast)		0.00	0.49	1.90	0.49
% of species total (South America)		0.00	0.35	0.05	0.13
% of size-class total (Atlantic Coast)		0.00	0.48	0.01	0.49
% of grand total (Atlantic Coast)		0.00	0.08	0.00	0.08
Tierra del Fuego	430.0				
No. of birds		14	19 472	0	19 486
% of species total (Atlantic Coast)		6.67	59.53	0.00	58.77
% of species total (South America)		0.06	42.77	0.00	16.06
% of size-class total (Atlantic Coast)		0.04	58.73	0.00	58.77
% of grand total (Atlantic Coast)		0.01	9.57	0.00	9.58
All Argentina	4 549.0				
No. of birds		20	20 726	60	20 806
% of species total (South America)		0.08	45.52	0.92	17.15
% of size-class total (South America)		0.02	17.08	0.05	17.15
% of grand total (South America)		0.00	0.71	0.00	0.71

of the Rio de la Plata estuary and were deposited during the Holocene sea-level transgression (Ottman and Urien 1965; Urien 1967). Offshore environments consist predominantly of sand off the coast of Buenos Aires province between Punta Rasa nearly to Bahia Blanca, as well as south of Bahia San Blas to the Golfo San Matias; coastal sediments apparently result from the reworking of this material, as there is no significant supply from the rivers along the present shoreline (Urien and Ewing 1974).

The outer coastline between Punta Rasa and Mar del Plata (Sectors 8–11 and 13) consists essentially of ocean beach, backed in many places by extensive dunes (Table 11.6). Many of the beaches are used by tourists. Nearctic shorebirds were practically absent from this stretch of coast: only two medium-sized birds were observed, probably Lesser Golden-Plovers.

Water conditions in the Laguna Mar Chiquita (Sector 12) to the north of Mar del Plata vary from brackish near the mouth of the lagoon to fresh towards its inner parts, and muddy banks and marshes are found around its borders. The few Nearctic shorebirds seen included a flock of 50 peeps and a similar number of yellowlegs, although large numbers of waterfowl were recorded.

The immediate shoreline between Mar del Plata and Bahia Blanca (Sectors 14–22) generally consists of beach (Tables 11.6, 11.8, and 11.10). Low, eroding cliffs 15–30 m high are found in this stretch, either at the coast or somewhat inland. Large dune fields have been built up along much of the south-facing shoreline of Buenos Aires province, in some places enclosing a series of small, elongated lagoons.

Very few Nearctic shorebirds (or other birds) were seen along the cliffy, eroding coastlines between Mar del Plata and Laguna Salada (Sectors 14–17). At Laguna Salada, the series of lagoons and wetlands running parallel to the coast behind the outer line of dunes (Sector 18) supported some Nearctic shorebirds, mainly yellowlegs, and moderate numbers of waterfowl and gulls (Table 11.7). Flocks of Sanderlings occurred along the outer beaches between Laguna Salada and Bahia Blanca (Sectors 19–22; Tables 11.7 and 11.9) and often appeared to be associated with patches of beachrock/tough mud, which were a feature of this stretch of coast. In addition to the appearance of Sanderlings, oystercatchers were more numerous in this area than farther north. In general, however, concentrations of Nearctic shorebirds were very low along the outer

Map 11.1 (Argentina-1)
Distribution of Nearctic shorebirds along the Buenos Aires coast of Argentina

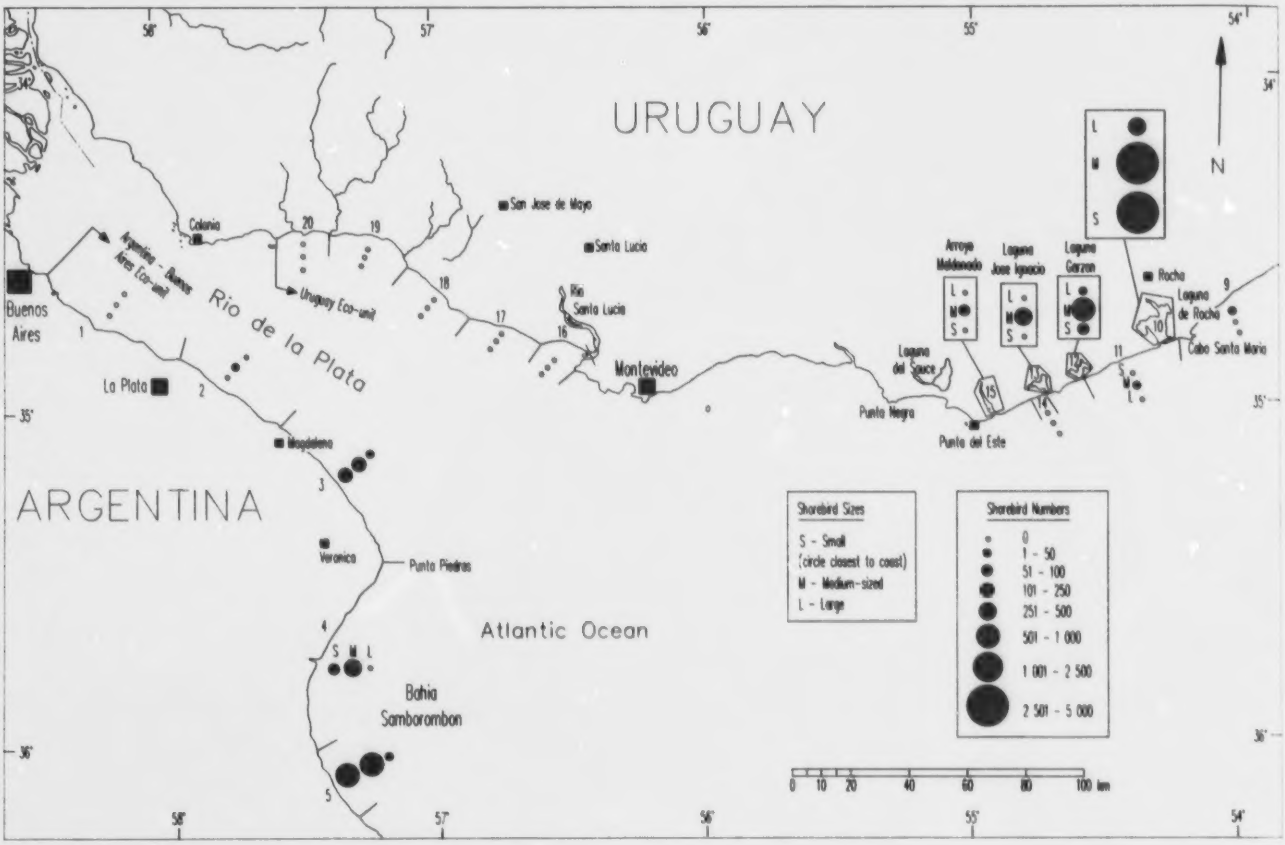

URUGUAY
ARGENTINA
Rio de la Plata
Atlantic Ocean
Buenos Aires
La Plata
Magdalena
Veronica
Punta Piedras
Bahia Samborombon
Colonia
San Jose de Mayo
Santa Lucia
Rio Santa Lucia
Montevideo
Punta Negra
Punta del Este
Laguna del Sauce
Arroyo Maldonado
Laguna Jose Ignacio
Laguna Garzon
Rocha
Laguna de Rocha
Cabo Santa Maria
Argentina - Buenos Aires Eco-unit
Uruguay Eco-unit
N
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
0 10 20 40 60 80 100 km
58°
57°
56°
55°
54°
34°
35°
36°

Table 11.3
Totals of Nearctic shorebirds in survey sectors in Map 11.1 (Argentina-1)

Sector no.	Sector length (km)	Small shore-bird species	Total small shore-birds	Lesser Golden-Plover	Yellow-legs species	Medium-sized shore-bird species	Total medium-sized shore-birds	Whimbrel	Hudson-ian Godwit	Large shore-bird species	Total large shore-birds	Unclas-sified shore-birds	Total shore-birds
1	59.4	0	0	0	0	0	0	0	0	0	0	0	0
2	38.5	0	0	0	2	0	2	0	0	0	0	3	5
3	65.0	124	124	5	66	37	108	4	0	2	6	0	238
4	66.8	65	65	0	91	215	306	0	0	0	0	100	471
5	49.1	852	852	0	139	769	908	0	5	0	5	0	1 765
Total	278.8	1 041	1 041	5	298	1 021	1 324	4	5	2	11	103	2 479

Table 11.4
Principal habitats in survey sectors in Map 11.1 (Argentina-1)

Sector no.	Habitat description
1	Brackish estuary; some mudbanks and flats with marsh / scrub / farmland, wetlands, urban development
2	Brackish estuary; mudbanks with marshy edge / scrubby grasslands / farmland, wetlands
3	Brackish estuary; mudbanks with marshy edge / scrubby grassland / farmland, wetlands
4	Wide mudflats, salt marsh / grassland, marsh, ponds
5	Wide mudflats, salt marsh / grassland, marsh, ponds

beaches, and most birds were found, again in low numbers, in the lagoons behind the shoreline.

11.7. Rio Colorado eco-unit

Sectors 23–33; Maps 11.4 (Argentina-4) and 11.5 (Argentina-5)

The Rio Colorado eco-unit extends southwards from Bahia Blanca along the southern coastline of Buenos Aires province and the northern shore of the Golfo San Matias to just east of the estuary at San Antonio Oeste. The eco-unit contains two general types of coastline—the first consists of the extensive estuarine areas at Bahia Blanca and south of the Rio Colorado between Bahia Union and Bahia San Blas, and the second comprises the

Map 11.2 (Argentina-2)
Distribution of Nearctic shorebirds along the Mar del Plata coast of Argentina

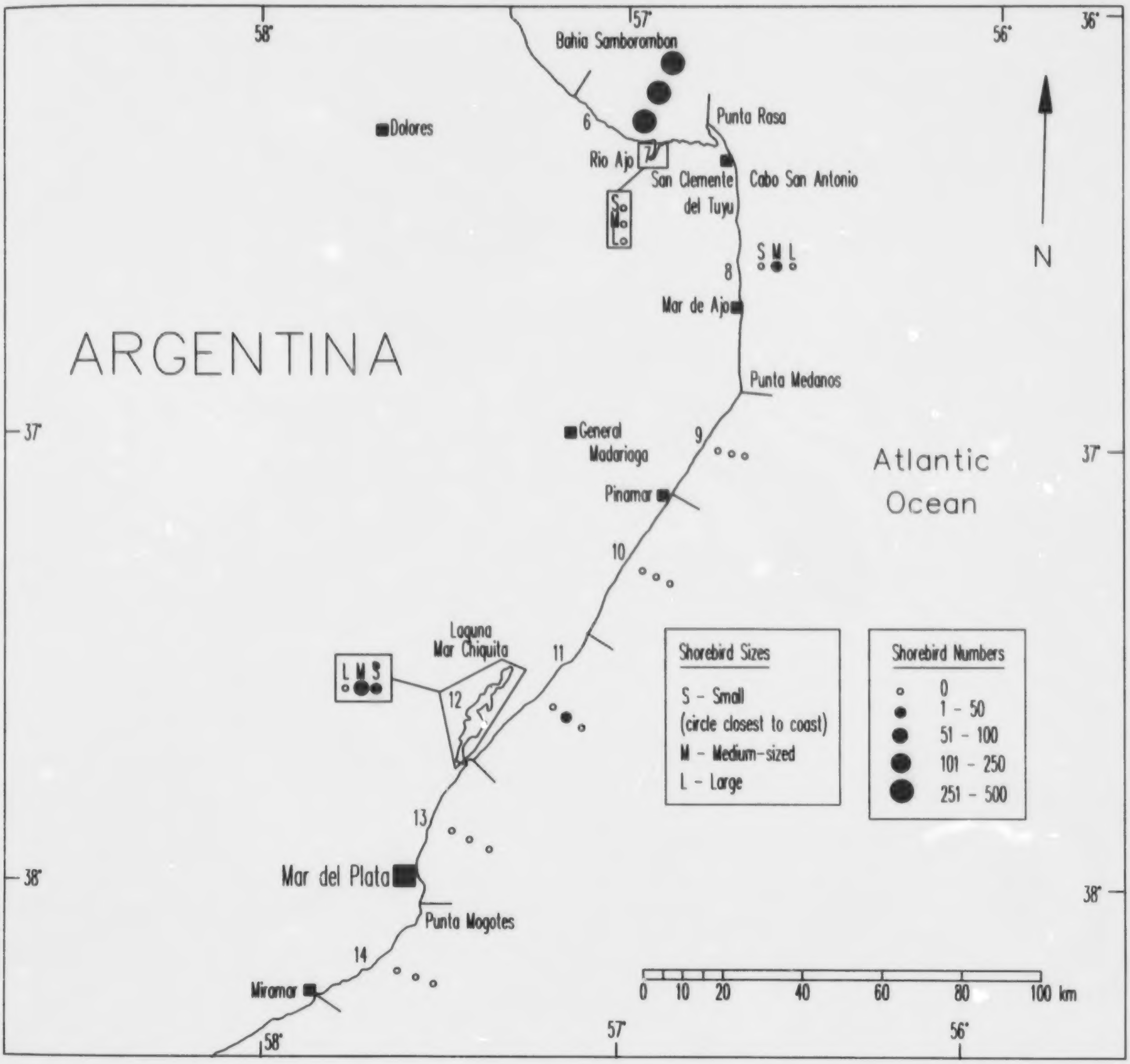

58°
57°
56°
36°
37°
38°
Bahia Samborombon
Punta Rasa
Dolores
6
Rio Ajo
7
San Clemente del Tuyu
Cabo San Antonio
S M L
8
Mar de Ajo
ARGENTINA
Punta Medanos
General Madariaga
9
Atlantic Ocean
Pinamar
10
Laguna Mar Chiquita
11
12
L M S
13
Mar del Plata
Punta Mogotes
14
Miramar
N
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
0 10 20 40 60 80 100 km

Table 11.5
Totals of Nearctic shorebirds in survey sectors in Map 11.2 (Argentina-2)

Sector no.	Sector length (km)	Small shorebird species	Total small shorebirds	Yellowlegs species	Medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Hudsonian Godwit	Large shorebird species	Total large shorebirds	Total shorebirds
6	40.9	275	275	233	111	344	1	424	45	470	1 089
7	0.0	0	0	0	0	0	0	0	0	0	0
8	67.5	0	0	0	1	1	0	0	0	0	1
9	33.4	0	0	0	0	0	0	0	0	0	0
10	45.3	0	0	0	0	0	0	0	0	0	0
11	44.1	0	0	0	1	1	0	0	0	0	1
12	0.0	50	50	51	25	76	0	0	0	0	126
13	42.8	0	0	0	0	0	0	0	0	0	0
14	34.6	0	0	0	0	0	0	0	0	0	0
Total	308.6	325	325	284	138	422	1	424	45	470	1 217

mixture of beaches, *restingas*, and cliffs running from Bahia San Blas along the north shore of Golfo San Matias to San Antonio Oeste.

11.7.1. Bahia Blanca to Bahia San Blas

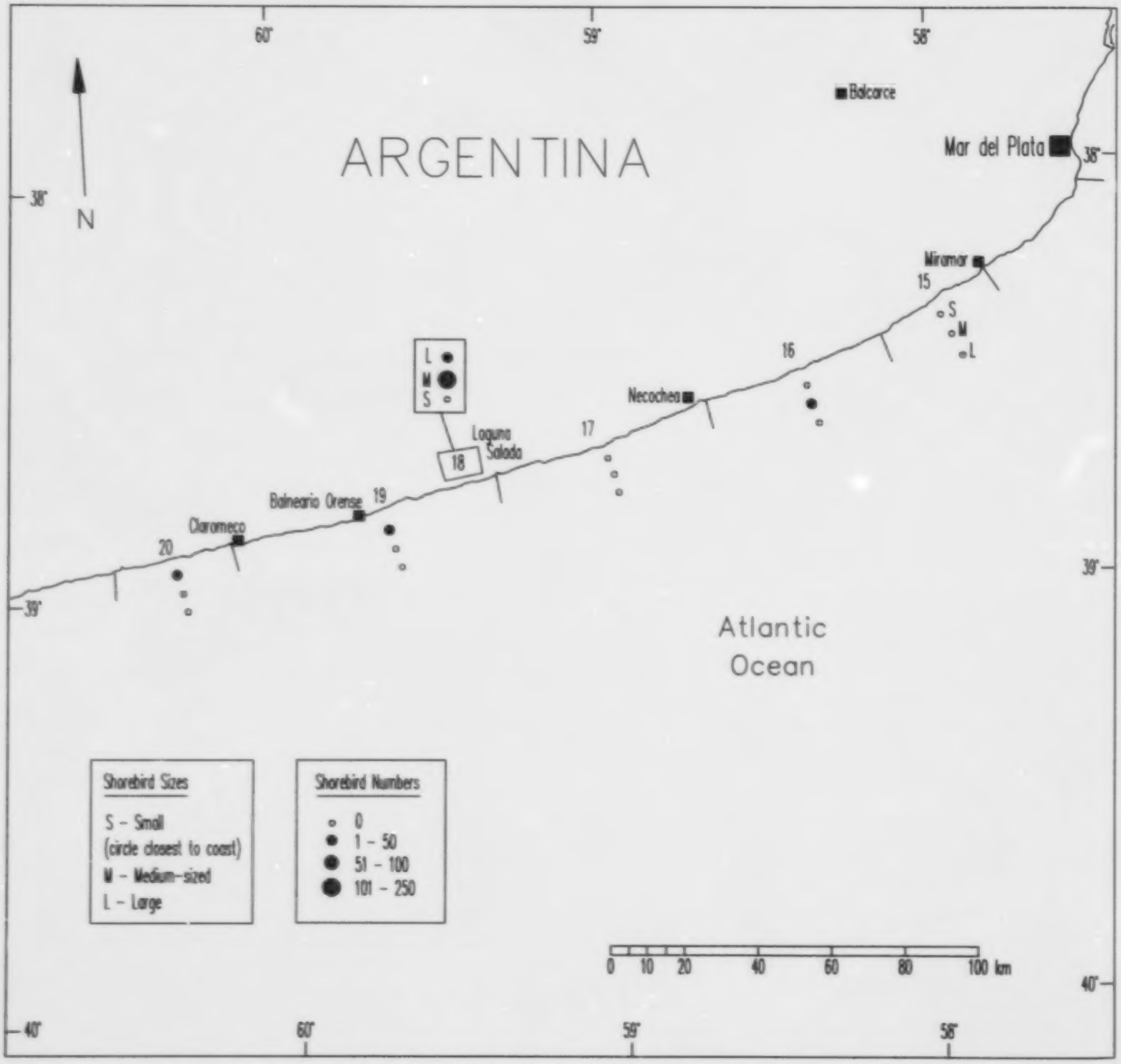
Sectors 23–26; Map 11.4 (Argentina-4)

A narrow coastal plain runs from around Bahia Blanca to the southern end of the Bahia Union/Bahia Anegada/Bahia San Blas complex, forming the onshore portion of the Colorado Basin, whose contours may be traced far offshore (Ewing *et al.* 1963; Urien and Ewing 1974).

Table 11.6
Principal habitats in survey sectors in Map 11.2 (Argentina-2)

Sector no.	Habitat description
6	Wide channelled mudflats, sandbars, salt marsh / grassland, ponds
7	Inland; freshwater marsh / grassland, farmland
8	Narrow sand beach / vegetated dunes / scrubby grassland
9	Wide sand beach / dunes / scrubby desert
10	Narrow sand beach / dunes / desert, grassland
11	Narrow sand beach / dunes / scrubby desert, lagoon
12	Inland; brackish lagoon with mudbanks and flats, salt marsh / scrub, marsh
13	Narrow sand beach with rocky outcrops / low cliffs / desert, urban development
14	Narrow sand beach / low cliffs / scrubby desert

Map 11.3 (Argentina-3)
Distribution of Nearctic shorebirds along the Necochea coast of Argentina


60°
59°
58°
N
ARGENTINA
Balcarce
Mar del Plata
38°
Miramar
15
S
M
L
16
Necochea
17
L
M
S
18
Laguna Salada
Balneario Orense
19
Claromeco
20
39°
Atlantic Ocean
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
0
10
20
40
60
80
100 km
40°

Some 18 000 years BP, the sea level was about 140 m lower than today, and the shoreline ran approximately along the border of what is now the submerged continental shelf. The sea level subsequently rose, covering the coastal plain and becoming stabilized, after some fluctuations, in its present position (Urien and Ewing 1974). During this period, material brought down by the rivers was deposited within estuaries and then dispersed by longshore currents along the coastline (Urien and Ewing 1974). The Colorado/Negro rivers spread their loads southwards into what is now the Golfo San Matias, as well as northwards along the San Blas and Bahia Blanca bays, with a narrow belt of muddy sand (Urien and Ewing 1974). Patagonian rivers appear to have had a high load capacity during the Holocene, expelling a considerable sand stock onto the inner shelf and probably being the main source of these sediments. The principal rivers in the area have smaller runoffs than the Rio de la Plata: runoff from the Rio Colorado is 180 $m^3 \cdot s^{-1}$ and from the Rio Negro 950 $m^3 \cdot s^{-1}$, compared with 23 000 $m^3 \cdot s^{-1}$ from the Rio de la Plata (Urien and Ewing 1974). Most discharged sediment appears to be trapped within the present estuarine system, and the strong tidal offshore currents rework the sandy bottom. With reduced fluvial conditions, the area was classified by Urien and Ewing (1974) as a high destructive dominant tide and wave system.

Owing to flight-path restrictions, it was necessary to fly a straight-line transect across Bahia Blanca (Sector 23), southwards past the west end of Isla Trinidad to Punta Laberinto. The upper estuary contained many channels lined with muddy banks and extensive areas of flats; marsh vegetation included *Salicornia*, *Juncus*, and *Spartina*. The relatively few Nearctic shorebirds that were seen during the transect included occasional flocks of peeps and Lesser Golden-Plovers. It is likely that the area is of considerably greater importance than indicated by the survey, as the flight was conducted at low tide and only a restricted part of the bay could be covered.

The coastline between Bahia Blanca and Bahia Union (Sector 24) consisted of ocean beach backed by extensive areas of dunes and scrubby desert (Table 11.10). Some marshy areas occurred around the mouth of the northern channel of the Rio Colorado. Very few Nearctic shorebirds were observed on the beaches in this sector.

Both Bahia Union (Sector 24) and Bahia Anegada/Bahia San Blas (Sector 25) contained very extensive areas of intertidal mudflats and sandflats with drainage channels; the flats were backed by salt marsh leading to scrubby desert, in which a number of large *salitrals* (dried-out saline lagoons) were found. Low arid islands are found in the intertidal zone, particularly in Bahia Anegada/Bahia San Blas, on one of which was discovered a new colony of an estimated 300 to 400 pairs of Chilean Flamingos *Phoenicopterus chilensis*. Vegetation along the channels and in the marshes included various species of *Spartina* and *Juncus*.

Surveys occurred during low tide, making efficient coverage of the enormous areas of exposed intertidal flats difficult. Nevertheless, substantial numbers of Nearctic shorebirds were observed. Several large flocks of peeps were seen, the total of 4500 representing 10.9% of the Argentinian total and 6.4% of the total for the Atlantic Coast. One flock of Red Knots was identified among the total of 1800 medium-sized shorebirds. The area was also notable for Hudsonian Godwits, with a total of some 310 seen in the area (Table 11.9). In view of the problematical survey conditions, it is possible these bays are considerably more important for shorebirds than indicated by the present results.

11.7.2. Bahia San Blas to San Antonio Oeste

Sectors 27–33; Maps 11.4 (Argentina-4) and 11.5 (Argentina-5)

The coastline south of Bahia San Blas to the mouth of the Rio Negro (Sectors 27 and 28) consisted of ocean beach backed by grassy dunes, leading to a scrubby desert inland (Table 11.10). Very few birds were seen on this section, not even gulls or oystercatchers. The only flock of shorebirds observed was one of 50 peeps near the mouth of the Rio Negro (Table 11.9).

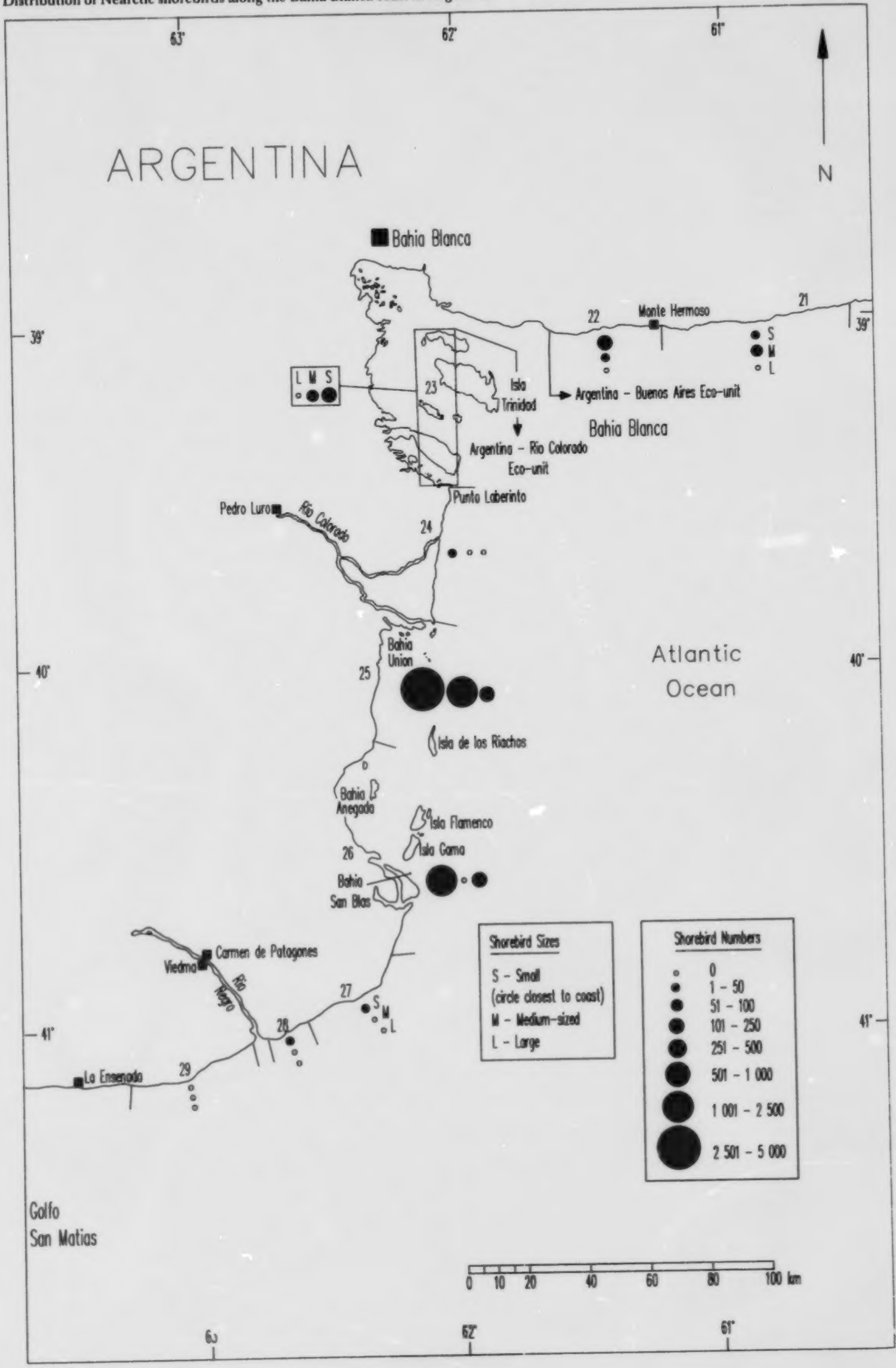
Table 11.7
Totals of Nearctic shorebirds in survey sectors in Map 11.3 (Argentina-3)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
15	40.0	0	0	0	0	0	0	0	0	0
16	46.0	0	0	0	4	3	7	0	0	7
17	55.3	0	0	0	0	0	0	0	0	0
18	0.0	0	0	0	56	90	146	1	1	147
19	62.1	44	0	44	0	0	0	0	0	44
20	39.1	40	3	43	0	0	0	0	0	43
Total	242.5	84	3	87	60	93	153	1	1	241

Table 11.8
Principal habitats in survey sectors in Map 11.3 (Argentina-3)

Sector no.	Habitat description
15	Narrow sand beach / low cliffs, dunes / scrubby desert
16	Narrow sand beach, some hard muddy sections / dunes / farmland, marsh, ponds
17	Narrow sand beach / dunes, low cliffs / scrubby desert, farmland
18	Inland; freshwater pond and marsh / dunes, farmland
19	Narrow sand beach with some rocky outcrop / broad dunes
20	Sand beach with scattered rocky shelves / sandy desert, farmland

Map 11.4 (Argentina-4)
Distribution of Nearctic shorebirds along the Bahia Blanca coast of Argentina



63°
62°
61°
N
ARGENTINA
Bahia Blanca
39°
21
22
Monte Hermoso
S
M
L
L M S
23
Isla Trinidad
Argentina – Buenos Aires Eco-unit
Bahia Blanca
Argentina – Rio Colorado Eco-unit
Punta Laberinto
Pedro Luro
Rio Colorado
24
Bahia Union
25
40°
Atlantic Ocean
Isla de los Riachos
Bahia Anegada
Isla Flamenco
Isla Gama
26
Bahia San Blas
Carmen de Patagones
Viedma
Rio Negro
27
S
M
L
28
41°
29
La Ensenada
Shorebird Sizes
S – Small (circle closest to coast)
M – Medium-sized
L – Large
Shorebird Numbers
0
1 – 50
51 – 100
101 – 250
251 – 500
501 – 1 000
1 001 – 2 500
2 501 – 5 000
Golfo San Matias
0
10
20
40
60
80
100 km
63°
62°
61°

Table 11.9
Totals of Nearctic shorebirds in survey sectors in Map 11.4 (Argentina-4)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Lesser Golden-Plover	Black-bellied Plover	Yellowlegs species	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
21	64.7	26	0	26	80	0	0	0	0	80	0	0	0	106
22	27.2	143	3	146	0	0	0	0	15	15	0	0	0	161
23	55.0	4	132	136	30	5	0	0	24	59	0	0	0	195
24	44.1	4	1	5	0	0	0	0	0	0	0	0	0	5
25	398.8	0	3 509	3 509	0	0	1	50	1 736	1 787	163	5	168	5 464
26	186.2	0	1 020	1 020	0	0	0	0	0	0	150	0	150	1 170
27	43.6	1	0	1	0	0	0	0	0	0	0	0	0	1
28	12.4	0	50	50	0	0	0	0	0	0	0	0	0	50
29	43.8	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	875.8	178	4 715	4 893	110	5	1	50	1 775	1 941	313	5	318	7 152

Table 11.10
Principal habitats in survey sectors in Map 11.4 (Argentina-4)

Sector no.	Habitat description
21	Wide sand beach / sandy desert, farmland
22	Sand beach with some rock and mud sections / dunes / grassland, scrub
23	Brackish estuary; channelled mud- and sandflats / scrub
24	Sand beach / dunes / scrubby desert
25	Brackish estuary; broad channelled mudflats, salt marsh / scrub
26	Brackish estuary; broad channelled mudflats, salt marsh / scrub
27	Sand beach / grassy dunes / scrub
28	Sand beach / grassy dunes / scrub
29	*Restinga*, sand and pebble beaches / cliffs, some dunes / scrubby grasslands

West of the mouth of the Rio Negro, the north shore of the Golfo San Matias consists principally of sand or gravel beaches, backed mostly by cliffs and occasionally by dunes. Vast expanses of Patagonian scrubby grassland stretch inland. *Restingas* occur along much of the shore; many of these rocky platforms were highly wave-cut, with deeply indented and corrugated surfaces. They appeared to be used by gulls, although shorebirds were not observed on them on this part of the coast.

Near Punta Mejillon (Sector 32), the coastline opens into a wide sandy embayment, with enormous sandflats backed by dunes (Table 11.12). This area represents one of several small elements of coastal plain that have accumulated around the margin of the Golfo San Matias; such areas occur on its central northern coast, at San Antonio Oeste, and along the west shore (Urien and Ewing 1974) and appear to be particularly significant in supporting most of the shorebirds observed around the gulf. Moderate concentrations of Sanderlings were found along the sandy shoreline of the wide bay near Punta Mejillon (Sector 32), the 230 birds representing 12.5% of the Argentinian total (2.5% of the Atlantic Coast total; Table 11.11).

11.8. Peninsula Valdes eco-unit

Sectors 34–57; Map 11.5 (Argentina-5)

The Peninsula Valdes eco-unit stretches from San Antonio Oeste around the western side of the Golfo San Matias, the Peninsula Valdes, and southwards to Bahia Engano at Rawson and includes many important habitats for shorebirds.

The Golfo San Matias is a wide and deep embayment lined with sandy and gravelly beaches and *restingas*; clay deposits in its depression may have been brought in recent times from the Rio Negro by counterclockwise tidal currents entering the gulf (Pierse *et al.* 1969; Urien and Ewing 1974). Its centre reaches 130 m in depth, although a seaward sill that separates it from the continental shelf is only 37 m deep (Pierse *et al.* 1969).

The estuary at San Antonio Oeste and much of the western coast of the Golfo San Matias represent elements of coastal plain (Urien and Ewing 1974); these areas supported moderate numbers of shorebirds. Maximum spring tidal ranges are 8–9 m at San Antonio Oeste (Schnack 1985); extensive sandy shoals and flats occur around the mouth of the estuary, and a large area of tidal salt marsh without freshwater inflow occurs behind a sandy barrier spit. Only a few Nearctic shorebirds were seen on the inside of the estuary (16 Sanderlings near the base of the outer spit). Significant numbers of Sanderlings were observed along the outer spit on the eastern side of the estuary, the total of 490 representing 5.3% of the Atlantic Coast total and 26.5% of the Argentinian total (Table 11.11).

Much of the western side of the Golfo San Matias consisted of rocky sections, often consisting of *restingas* backed by sandy or gravel beaches, alternating with sandier sections. Dunes occurred along some parts of the coast, but the hinterland consisted mostly of flat open scrubland. Cliffs became more prominent along the southern part of the bay towards the Peninsula Valdes. The *restingas* in the northern stretch of coast were often highly eroded and uneven and supported few shorebirds; other rocky intertidal areas were smoother, appeared to be more heavily colonized by algae and invertebrates, and supported most of the shorebirds seen. The central parts of the west coast (Sectors 38–40) contained the highest numbers of shorebirds seen around the Golfo San Matias. Small flocks of peeps were found along vegetated rocky foreshores and stretches of sandy shore alternating with rocky areas, and a further 200 Sanderlings (10.8% of the Argentinian total) occurred just south of Punta Pozos (Sector 39). The 1200 Red Knots seen north of Puerto Lobos in Sector 40 were in one of several flocks seen around the area of the Peninsula Valdes, the sector total

Map 11.5 (Argentina-5)
Distribution of Nearctic shorebirds along the Peninsula Valdes coast of Argentina

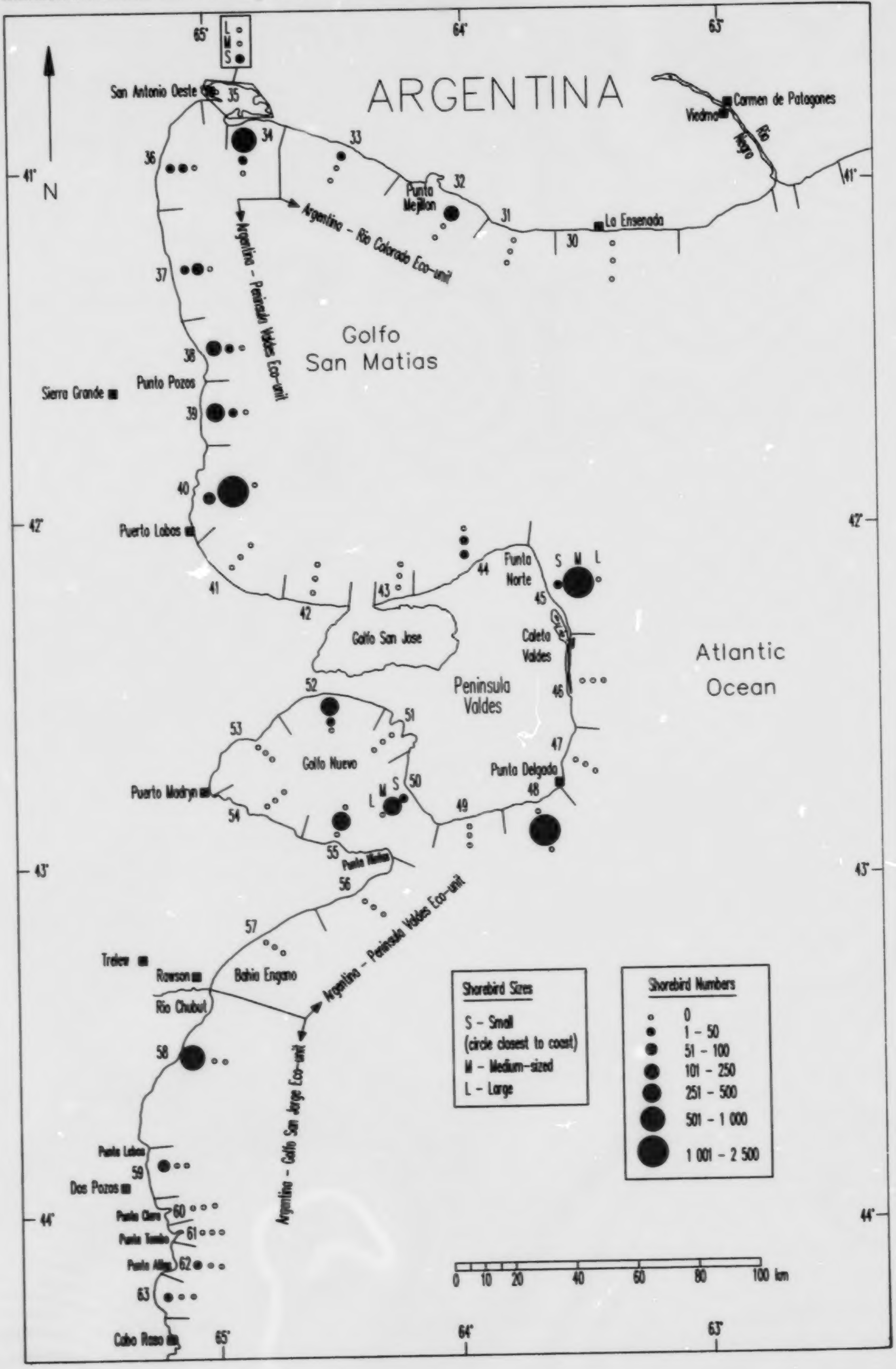

ARGENTINA
N
L
M
S
San Antonio Oeste
Carmen de Patagones
Viedma
Rio Negro
Punta Mejillon
La Ensenada
Argentina - Rio Colorado Eco-unit
Argentina - Peninsula Valdes Eco-unit
Golfo San Matias
Sierra Grande
Punta Pozos
Puerto Lobos
Punta Norte
Golfo San Jose
Caleta Valdes
Peninsula Valdes
Atlantic Ocean
Golfo Nuevo
Puerto Madryn
Punta Delgada
Punta Ninfas
Trelew
Rawson
Bahia Engano
Rio Chubut
Argentina - Golfo San Jorge Eco-unit
Punta Lobos
Dos Pozos
Punta Clara
Punta Tombo
Punta Atlas
Cabo Raso
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63
65° 64° 63°
41° 42° 43° 44°
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
0 10 20 40 60 80 100 km

Table 11.11
Totals of Nearctic shorebirds in survey sectors in Map 11.5 (Argentina-5)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Yellowlegs species	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Total large shorebirds	Unclassified shorebirds	Total shorebirds
30	32.2	0	0	0	0	0	0	0	0	0	0	0
31	20.2	0	0	0	0	0	0	0	0	0	0	0
32	35.2	231	0	231	0	0	0	0	0	0	0	231
33	39.0	0	15	15	0	0	0	0	0	0	0	15
34	24.9	490	150	640	5	0	0	0	5	0	0	645
35	79.9	16	0	16	0	0	0	0	0	0	0	16
36	43.4	0	40	40	0	1	0	0	1	0	0	41
37	37.5	0	7	7	0	51	0	0	51	0	0	58
38	23.7	0	180	180	0	3	0	0	3	0	0	183
39	20.7	200	200	400	0	0	21	0	21	0	0	421
40	26.9	0	61	61	0	0	1 202	0	1 202	0	0	1 263
41	47.1	0	0	0	0	0	0	0	0	0	0	0
42	18.2	0	0	0	0	0	0	0	0	0	0	0
43	13.4	0	0	0	0	0	0	0	0	0	0	0
44	44.8	40	0	40	0	0	0	1	1	0	0	41
45	37.8	10	0	10	0	0	1 000	1	1 001	0	0	1 011
46	30.0	0	0	0	0	0	0	0	0	0	0	0
47	20.3	0	0	0	0	0	0	0	0	0	0	0
48	25.7	0	0	0	0	0	2 000	0	2 000	0	0	2 000
49	21.0	0	0	0	0	0	0	0	0	0	0	0
50	26.5	21	0	21	0	0	500	0	500	0	0	521
51	26.6	0	0	0	0	0	0	0	0	0	0	0
52	36.3	0	400	400	0	0	0	1	1	0	1	402
53	29.0	0	0	0	0	0	0	0	0	0	0	0
54	39.4	0	0	0	0	0	0	0	0	0	0	0
55	36.7	0	0	0	0	0	300	0	300	0	0	300
56	36.8	0	0	0	0	0	0	0	0	0	0	0
57	38.3	0	0	0	0	0	0	0	0	0	0	0
58	63.4	30	808	838	0	0	0	0	0	0	40	878
59	19.7	0	99	99	0	0	0	0	0	0	0	99
60	8.5	0	0	0	0	0	0	0	0	0	0	0
61	8.7	0	0	0	0	0	0	0	0	0	0	0
62	12.8	0	5	5	0	0	0	0	0	0	0	5
63	23.9	40	10	50	0	0	0	0	0	0	0	50
Total	1 048.5	1 078	1 975	3 053	5	55	5 023	3	5 086	0	41	8 180

Table 11.12
Principal habitats in survey sectors in Map 11.5 (Argentina-5)

Sector no.	Habitat description
30	*Restinga*, narrow sand beach / cliffs / scrubby grassland
31	*Restinga*, narrow sand beach / cliffs / scrubby grassland
32	*Restinga*, wide sand beach with pebbly sections / cliffs, dunes / scrubby grassland
33	*Restinga*, narrow sand beach / cliffs, dunes / scrubby grassland
34	Sand beach / dunes / scrubby grassland
35	Brackish estuary; sandflats, bars, marsh / scrubby grassland
36	Sand beach and flats, *restinga* / dunes, eroded cliffs / open scrub
37	Sand beach and flats, *restinga* / dunes, eroded cliffs / open scrub
38	*Restinga*, some sand beach / eroded cliffs / open scrub
39	Narrow rocky shore, *restinga* / cliffs / open scrub
40	*Restinga*, sand beach / cliffs / open scrub
41	Sand beach, *restinga* / cliffs, dunes / open scrub
42	Gravel beach, *restinga* / cliffs / open scrub
43	*Restinga* / cliffs / open scrub
44	*Restinga*, rocky shelves, sand and gravel beaches / cliffs / open scrub
45	Gravel beach / eroded cliffs / open scrub
46	Gravel beach / cliffs / open scrub
47	Cliffs, narrow sand beach in places / open scrub
48	Gravel beach, cliffs in places / open scrub
49	Gravel beach, cliffs in places / open scrub
50	Sand beach / dunes / open scrub
51	Sand and gravel beaches, cliffs in places / open scrub
52	Narrow sand and gravel beaches, rocky headlands / cliffs / open scrub
53	Sand and gravel beaches, rocky headlands / cliffs / open scrub
54	Sand and gravel beaches, rocky headlands / cliffs / open scrub
55	Gravel beach, some rocky headlands / cliffs / open scrub
56	Narrow gravel and sand beaches / cliffs / open scrub
57	Narrow gravel and sand beaches / cliffs / open scrub
58	Gravel beach, some sand beach and *restinga* / cliffs / open scrub
59	Gravel beach, some rocky shelves / cliffs / open scrub
60	Gravel beach, some rocky headlands and offshore islands / open scrub hills
61	Gravel beach, some rocky headlands and offshore islands / open scrub hills
62	Gravel beach, some rocky headlands and offshore islands / open scrub hills
63	Gravel and sand beaches / low rolling scrub hills

representing 4.8% of the Argentinian total. Yellowlegs *Tringa* spp. were seen occasionally along the shoreline, with a flock of 50 birds observed in Sector 37 (Table 11.11).

Much of the north shore of the Peninsula Valdes was steep, cliffs or rocky headlands alternating with stretches of sandy or gravel beach, with or without *restingas*, which were often heavily wave-cut and channelled. The Golfo San Jose itself was not surveyed for logistical reasons: Jehl *et al.* (1973) reported small numbers of Nearctic shorebirds wintering in the area, and up to 400 Sanderlings and 1300 White-rumped Sandpipers have been observed (P. Canevari, unpubl. results); large numbers of Red Knots (6000+ , April 1981; pers. obs.) are known to use the beaches of Golfo San Jose during northward migration.

Much of the outer coastline on the east and south sides of the Peninsula Valdes consists of gravel beaches, with cliffs in places, backed by open scrubland. On the east coast of the peninsula, salt marshes occur at the northern end of the Caleta Valdes, a long narrow embayment separated from the ocean by a pebble spit some 30 km long. The outer spit represents the most recent of a sequence of Quaternary beach ridges alternating with depressions in which marshes were once found (Schnack 1985). Flocks of 1000 and 2000 Red Knots were found roosting on gravel beaches near the base of the Caleta Valdes (Sector 45) and near Punta Delgada (Sector 48), respectively. Smaller concentrations of knots were observed around the mouth of the Golfo Nuevo, with a flock of 500 on the north side in a stretch of sandy beaches and rocky headlands and a flock of 300 on the gravel beaches on the south side west of Punta Ninfas. Much of the shoreline of Golfo Nuevo consisted of sand or gravel beaches alternating with cliffs and rocky headlands backed by open scrub inland. Apart from the knots, few Nearctic shorebirds were observed, with the exception of 400 peeps on the north shore of the gulf (Sector 52; Table 11.11).

South of Punta Ninfas, the coast consists generally of gravel beaches backed by cliffs, becoming somewhat flatter and sandier towards Bahia Engano and Rawson (Sectors 56 and 57).

11.9. Golfo San Jorge eco-unit

Sectors 58–86; Maps 11.5 (Argentina-5) and 11.6 (Argentina-6)

The Golfo San Jorge eco-unit extends from Rawson to Cabo Blanco at the southern end of Golfo San Jorge. The eco-unit may be divided into three regions: the series of rocky headlands and gravel or sandy beaches running from Rawson to Cabo Aristizabal at the northern end of Golfo San Jorge (Sectors 58–73); the gravel beaches of the northern half of the Golfo San Jorge (Sectors 74–79); and the *restingas* running from Caleta Olivia to Cabo Blanco. Important shorebird areas were found in the area of Bahia Bustamante north of Cabo Aristizabal and along the above-mentioned *restingas*.

11.9.1. Rawson to Cabo Aristizabal

Sectors 58–73; Maps 11.5 (Argentina-5) and 11.6 (Argentina-6)

Between Rawson and Punta Clara (Sectors 58 and 59), much of the coastline consists of gravel and/or sand beaches, with sections of *restinga*; these are backed in places by cliffs, and Patagonian scrubland stretches inland (Table 11.12). Some 500 peeps were observed on the upper sandy flats south of the mouth of the Rio Chubut, with the remainder of the total of 810 in Sector 58 generally being found along rocky sections of the upper intertidal zone below the gravel beaches (Table 11.11).

To the south, stretches of rocky headlands are separated by sandier bays of varying length. Punta Clara (Sector 60), Punta Tombo (Sector 61), and Punta Atlas (Sector 62) consist of rocky promontories, with sections of gravel or sand beach in small bays, and much of the immediate shoreline is rocky and wave-washed. Very few Nearctic shorebirds were seen, although gulls were numerous and oystercatchers fairly common, and Punta Tombo is noted for its penguin and shag colonies. South of Punta Atlas, the shoreline opens out somewhat, consisting of gravel and sand beaches backed by low, rolling scrubby hills and, in some areas, by dried-out lagoons.

A similar sequence of shoreline follows to the south of Cabo Raso. Sectors 64 and 65 consisted of a series of rocky headlands interspersed with short sections of gravel or sand beach, with arid scrubland rising above the wave-washed shore; Sector 66 contained fairly steep sand and gravel beaches backed by open scrubland along the northern part of Bahia Camarones, with both types of shore along the southern section of the bay (Sector 67; Table 11.14). Few Nearctic shorebirds occurred along these coasts; occasional small flocks of Sanderlings were seen on sandy beaches and of peeps along the beaches or on rocky sections of shore; a few yellowlegs were seen in a small pond enclosed by a spit in Sector 67 (Table 11.13).

The coastline between Cabo Dos Bahias and Cabo Aristizabal (Sectors 68–73) again consisted of rocky headlands interspersed with rocky, wave-washed shores and sand and gravel beaches, backed by open scrubby terrain running inland (Table 11.14). The Bahia Bustamante area, however, was notable for the marshy areas occurring near the shoreline; marsh vegetation consists of *Spartina* and *Salicornia* spp., and the peaty soils found in the marsh are undergoing erosion (Schnack 1985). The Bahia Bustamante area contained important concentrations of Nearctic shorebirds, particularly Red Knots, the total of 7400 (Sectors 71 and 72) for this species representing 29.9% of the Argentinian total and 11.0% of the regional total for the Atlantic Coast (Table 11.13). Smaller, though significant, concentrations of peeps were also found roosting along the gravel beaches.

11.9.2. Northern half of Golfo San Jorge

Sectors 74–79; Map 11.6 (Argentina-6)

Much of the northern half of Golfo San Jorge (Sectors 74–79) consisted of long, gravel beaches backed by open scrubland, although cliffs reached the coast to the north and south of Commodoro Rivadavia in Sectors 76–78 (Table 11.14). In contrast to the coastline north and south of this stretch, very few Nearctic shorebirds were observed (Table 11.13).

11.9.3. Southern half of Golfo San Jorge, Caleta Olivia to Cabo Blanco

Sectors 80–86; Map 11.6 (Argentina-6)

Important shorebird habitats were found along the southern coastline of the Golfo San Jorge between Caleta Olivia and Cabo Blanco. Wide *restingas* backed by gravel and sand beaches ran along most of this stretch, with roll-

Restinga habitat, Patagonian coastline, Argentina. The *restingas* occurring along the southern coastlines of Argentina in Patagonia and Tierra del Fuego form a distinctive habitat consisting of rocky, intertidal, wave-cut platforms; they support significant numbers of shorebirds, especially Red Knots and Hudsonian Godwits.

ing open scrub or eroding cliffs inland; salt pans occurred behind the shoreline towards Cabo Blanco (Table 11.14). The *restingas* appear to be highly productive and are covered with a thick growth of algae and invertebrates, providing habitats and food resources for a variety of birds. The area supported significant numbers of several species, including Red Knots and Hudsonian Godwits, with totals of 1300 knots (5.2% of the Argentinian total) and 350 godwits (1.7% of the Argentinian total). Peeps were numerous, particularly in the northern sectors (4100 in Sectors 80–82), with the overall total of 5000 (12.7% of the Argentinian total) identifying the area as the most important one in Argentina outside of Tierra del Fuego. The area was also the only one in Argentina in which significant numbers of Ruddy Turnstones were observed, the flock of 300 representing 33.4% of the Atlantic Coast total (Table 11.13).

11.10. Rio Gallegos eco-unit

Sectors 87–115; Maps 11.7 (Argentina-7) and 11.8 (Argentina-8)

The Rio Gallegos eco-unit covers the southern Atlantic coast of Patagonia, stretching from Cabo Blanco to the tip of mainland Argentina at Punta Dungeness at the eastern entrance to the Strait of Magellan. This coastline includes the estuaries of the Rio Deseado, Rio San Julian, Rio Santa Cruz, Rio Coig, and Rio Gallegos, although only the outer shorelines of the river mouths were covered, for logistical reasons. Numbers of Nearctic shorebirds were low and restricted to a few localities.

No Nearctic shorebirds were seen between Cabo Blanco and Puerto Deseado (Sectors 87–89; Table 11.15); the coastline consisted of gravel beaches backed by flat open scrubland (Table 11.16). The area around the mouth of the Rio Deseado was rockier, and flocks of Hudsonian Godwits totalling 120 birds were found on the *restingas* south of the river exit. The coastlines of Cabo Mirador and Punta Medanosa consisted of low rocky points and headlands, with some beaches and cliffs, and grasslands stretching inland. Quite extensive areas of marshy wetland were noted on the north side of Punta Medanosa, and sandy areas backed by grassland on the south. The combination of sand and gravel beaches, nearby marshes, and some *restinga* areas appeared attractive to shorebirds: 400 Red Knots, 40 Hudsonian Godwits, and 1700 peeps were seen along the beaches and *restingas* south of the point, the largest concentrations of shorebirds found within the eco-unit. The only other concentration of Nearctic shorebirds noted was north of Cabo Danoso (Sector 97), where 150 Red Knots were found roosting on an extensive gravel spit north of an area of dried-up lagoons (Table 11.15).

No Nearctic shorebirds were seen on the outer coastline between Cabo Danoso and the Strait of Magellan (Sectors 98–115; Tables 11.15 and 11.17). Most of the coastline consisted of gravel beaches, often backed by steep lines of eroding cliffs, with the Patagonian plateau stretching inland, now mostly grassland rather than scrubland (Table 11.18). *Restingas* backed by cliffs occur along most of the coast between Punta Desengano and Rio Gallegos. Few roosting places may be available for birds along this type of shore.

At Rio Gallegos, the estuary was not surveyed, but there were extensive areas of intertidal flats uncovered, which were cut with meandering creeks and drainage channels and which appeared to consist of coarse sand and mud. Large, lush areas of *Salicornia* marsh lined the shore. South of the river mouth, the upper shoreline consisted of exposed sandflats leading up to gravel or sandy beaches, backed along the southern stretch by intermittent lines of eroding cliffs to Cabo Virgenes (Sectors 112–114; Table 11.18). Occasional small lagoons were formed where river mouths had been blocked off. A vast plateau of rolling tundra-like grassland stretched inland. A series of mudflats was found near Cabo Virgenes, and thick growths of weed choked the waters near the cliffs. No Nearctic shorebirds were seen in these areas during the surveys.

11.11. Tierra del Fuego eco-unit

Sectors 116–133; Map 11.9 (Argentina-9)

The Tierra del Fuego eco-unit comprises the Atlantic coast of Tierra del Fuego from the Argentina/Chile border south of Punta Catalina to the Le Maire Strait at Cabo San Diego. This coastline contains areas of major international importance for Nearctic shorebirds. Much of the coastline is steep, with rocky intertidal areas and *restingas*, although Bahia San Sebastian contains large areas of intertidal mudflats: important wintering sites occur on both types of coast.

The northern section of coast from the border with Chile to Bahia San Sebastian (Sectors 116 and 117) consists of sandflats with scattered rocks leading up to sandy or pebbly beaches; cliffs run along many parts of the coast, and rolling tundra-like grassland stretches inland from the shore (Table 11.20). Small lagoons occur where gravel barriers have dammed off river mouths, although fresh water

Map 11.6 (Argentina-6)
Distribution of Nearctic shorebirds along the Golfo San Jorge coast of Argentina

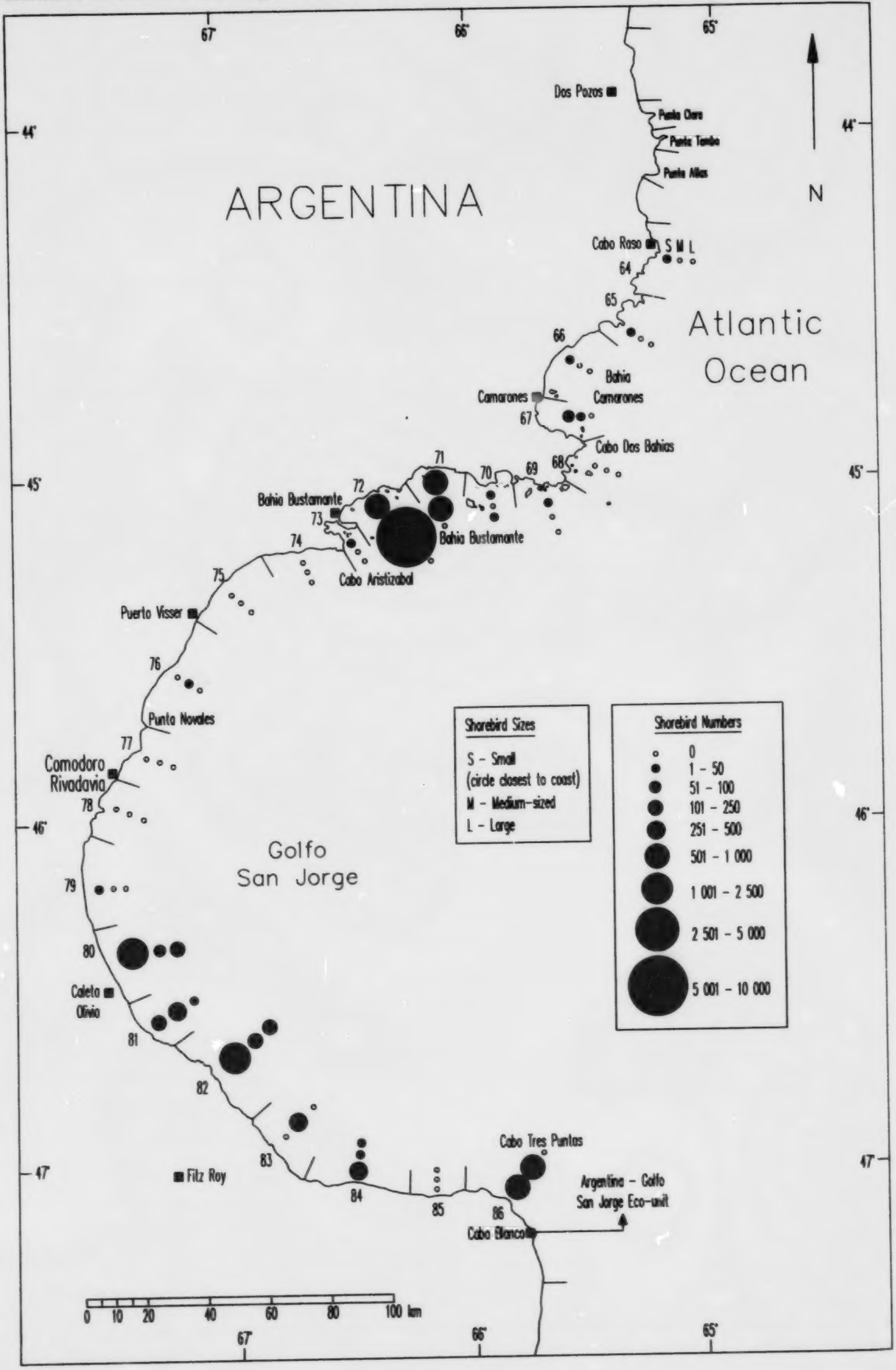

67°
66°
65°
44°
45°
46°
47°
N
ARGENTINA
Atlantic Ocean
Golfo San Jorge
Dos Pozos
Punta Clara
Punta Tombo
Punta Atlas
Cabo Raso
S M L
64
65
66
Bahia Camarones
Camarones
67
Cabo Dos Bahias
68
69
70
71
72
Bahia Bustamante
73
74
Bahia Bustamante
Cabo Aristizabal
75
Puerto Visser
76
Punta Novales
77
Comodoro Rivadavia
78
79
80
Caleta Olivia
81
82
83
Fitz Roy
84
85
Cabo Tres Puntas
86
Cabo Blanco
Argentina - Golfo San Jorge Eco-unit
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
0 10 20 40 60 80 100 km

Table 11.13
Totals of Nearctic shorebirds in survey sectors in Map 11.6 (Argentina-6)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Ruddy Turnstone	Yellowlegs species	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Unclassified shorebirds	Total shorebirds
64	23.0	0	40	40	0	0	0	0	0	0	0	0	0	40
65	27.4	0	6	6	0	0	0	0	0	0	0	0	0	6
66	30.4	5	30	35	0	0	0	0	0	0	0	0	0	35
67	25.0	0	100	100	0	7	0	0	7	0	0	0	0	107
68	15.8	0	0	0	0	0	0	0	0	0	0	0	0	0
69	20.2	0	50	50	0	0	0	0	0	0	0	0	0	50
70	20.8	0	24	24	0	0	0	0	0	0	5	5	50	79
71	20.6	0	652	652	0	10	500	0	510	0	0	0	0	1 162
72	30.2	0	575	575	0	0	6 900	0	6 900	0	0	0	0	7 475
73	23.5	0	20	20	0	0	0	0	0	0	0	0	0	20
74	24.2	0	0	0	0	0	0	0	0	0	0	0	0	0
75	31.3	0	0	0	0	0	0	0	0	0	0	0	0	0
76	35.2	0	0	0	20	0	0	0	20	0	0	0	0	20
77	18.5	0	0	0	0	0	0	0	0	0	0	0	0	0
78	20.6	0	0	0	0	0	0	0	0	0	0	0	0	0
79	34.1	0	50	50	0	0	0	0	0	0	0	0	0	50
80	25.8	0	2 100	2 100	0	0	0	100	100	200	0	200	0	2 400
81	22.0	0	145	145	0	0	470	0	470	40	0	40	0	655
82	37.5	0	1 865	1 865	0	0	130	0	130	110	0	110	0	2 105
83	23.6	0	0	0	300	0	0	0	300	0	0	0	0	300
84	28.8	0	310	310	0	0	5	0	5	2	0	2	0	317
85	22.4	0	0	0	0	0	0	0	0	0	0	0	0	0
86	33.0	0	595	595	0	0	686	0	686	0	0	0	0	1 281
Total	593.9	5	6 562	6 567	320	17	8 691	100	9 128	352	5	357	50	16 102

Table 11.14
Principal habitats in survey sectors in Map 11.6 (Argentina-6)

Sector no.	Habitat description
64	Rocky headlands, some gravel beach / open scrub
65	Rocky headlands, some gravel and sand beach / open scrub
66	Steep gravel and sand beaches / open scrub
67	Rocky headlands, some sand and gravel beaches / open scrub
68	Rocky headlands, some sand and gravel beaches / open scrub
69	Rocky headlands, some sand beaches / open scrub
70	Rocky headlands, some sand beaches / open scrub
71	Rocky headlands, some sand beaches / open scrub
72	Rocky headlands, some sand and gravel beaches / rolling open scrub
73	Rocky headlands, some gravel beaches / rolling open scrub, marsh
74	Gravel beach, some rocky platforms / rolling open scrub, dried salt pans
75	Steep gravel beach / low cliffs / rolling open scrub
76	Steep gravel beach / cliffs / rolling open scrub
77	Steep gravel beach / cliffs / open scrub
78	Sand beach, *restinga*, some rocky sections / cliffs / open scrub
79	Steep gravel beach / rolling open scrub, lagoons
80	Gravel beach, *restinga* / rolling open scrub, lagoons
81	*Restinga*, sand beach, some mudflats / rolling open scrub
82	*Restinga*, some sand beach / rolling open scrub
83	*Restinga*, some sand beach / rolling open scrub
84	*Restinga*, gravel and sand beaches / eroded cliffs / rolling open scrub
85	*Restinga*, gravel and sand beaches / rolling open scrub
86	*Restinga*, gravel beaches / open scrub, salt pans

does reach the ocean by seepage through such barriers. No Nearctic shorebirds were observed in these sectors.

Bahia San Sebastian is one of the most important wintering areas for Nearctic shorebirds in Argentina. On the seaward side, the northern part of the bay is enclosed by the Peninsula El Paramo, a shingle spit some 18 km long terminating at the Punta de Arenas. Large numbers of peeps were found roosting at the base of the spit, where there is a broad series of unvegetated ridges and hollows in the shingle between the bay and the ocean: some 14 700 birds, thought to be mostly White-rumped Sandpipers, were found in this area (Sector 118; Table 11.19) in February 1985. This figure alone represents some 37.1% of the Argentinian total and 20.8% of the Atlantic Coast total for peeps and is comparable with the major concentrations found in the south of Brazil in Rio Grande do Sul.

Vast flats up to an estimated 5 km in width occupy the northern part of Bahia San Sebastian. The flats in the upper part of the bay appeared to be dry and encrusted with salt, indicating that they were occasionally inundated. The lower flats in the central and eastern parts of the bay near the El Paramo spit were highly corrugated, with ridges and channels draining at right angles to the tide edge. At the edge of the spit, the channels were 0.5–1 m in depth, with a silty bottom over a gravel/mud base, and the ridges consisted of very soft and sticky clay/silt, making ground access to the flats very difficult. Large flocks of Hudsonian Godwits were found roosting along the tide edge, particularly in the eastern and central parts of the bay; some 19 300 godwits were counted in Sector 119. The flats on the southern and western sides of the bay become narrower and smoother, and fewer birds were observed in these areas (Sector 120). Bahia San Sebastian held nearly 19 400 Hudsonian Godwits, or some 42.6% of the continental total (59.3 and 93.4% of the Atlantic Coast and Argentinian totals, respectively), identifying it as the most important wintering area currently known for the species in South America. Tierra del Fuego held other important concentrations of Hudsonian Godwits, most notably at Bahia Lomas, Chile, only some 60 km northwest of Bahia San Sebastian, where a further 10 500 were found. Other smaller concentrations occurring elsewhere in the Tierra del Fuego/Strait of Magellan areas of Argentina and Chile brought the total for the area to 31 100 godwits, representing 68.4% of the South American total, or 95.2% of the regional Atlantic Coast total (Table 11.19).

Bahia San Sebastian also held significant numbers of Red Knots, the total of 4400 in Sectors 118–120

Map 11.7 (Argentina-7)
Distribution of Nearctic shorebirds along the Puerto Deseado coast of Argentina

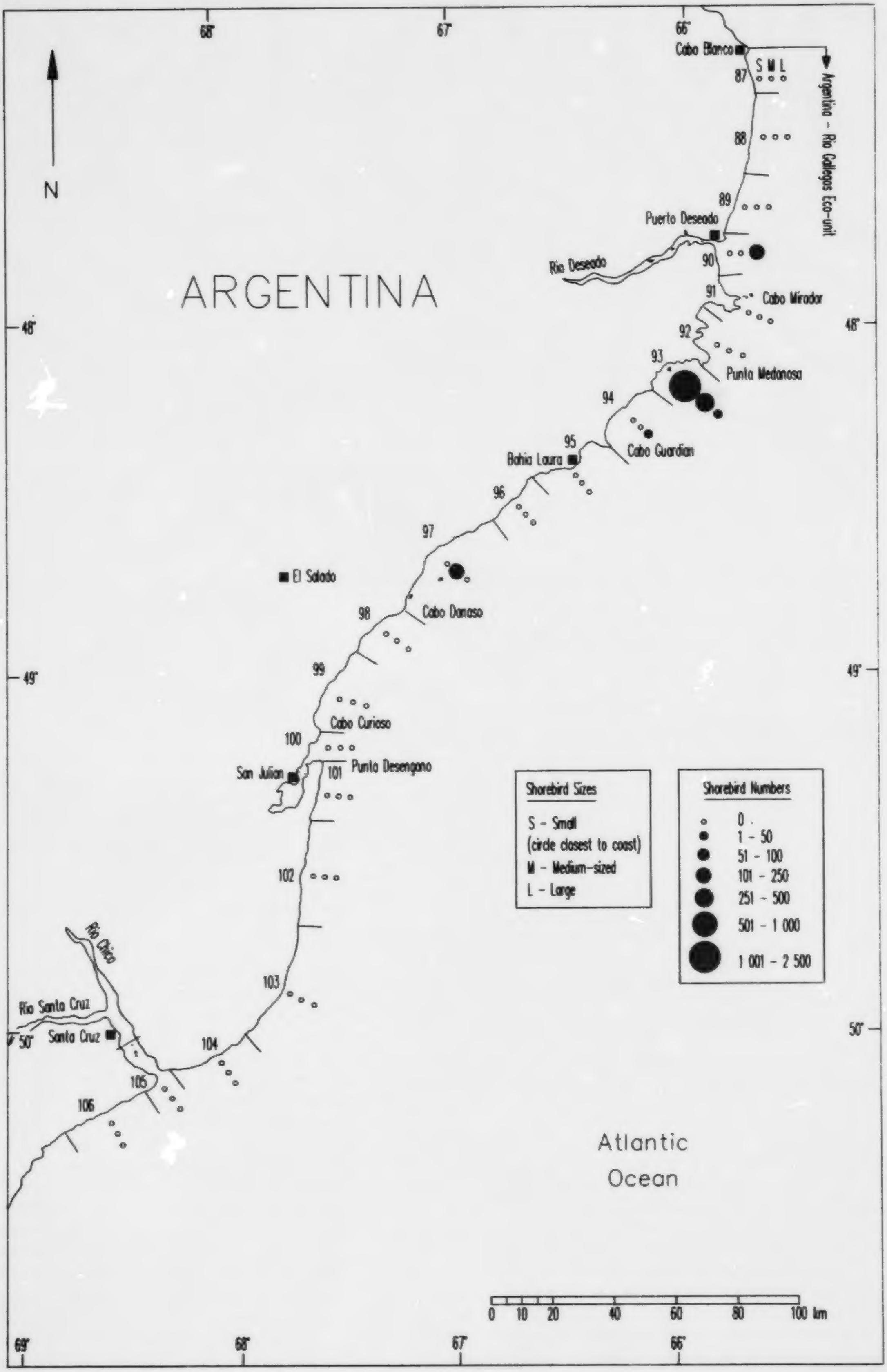

ARGENTINA
Atlantic Ocean
N
Argentina - Rio Gallegos Eco-unit
Cabo Blanco
Puerto Deseado
Rio Deseado
Cabo Mirador
Punta Medanosa
Cabo Guardian
Bahia Laura
El Salado
Cabo Danoso
Cabo Curioso
Punta Desengano
San Julian
Rio Chico
Rio Santa Cruz
Santa Cruz
S M L
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
68°
67°
66°
69°
48°
49°
50°
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
0
10
20
40
60
80
100 km

Table 11.15
Totals of Nearctic shorebirds in survey sectors in Map 11.7 (Argentina-7)

Sector no.	Sector length (km)	Unidentified small shorebird species	Total small shorebirds	Red Knot	Total medium-sized shorebirds	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
87	16.4	0	0	0	0	0	0	0	0
88	26.5	0	0	0	0	0	0	0	0
89	15.6	0	0	0	0	0	0	0	0
90	16.3	0	0	0	0	120	0	120	120
91	29.2	0	0	0	0	0	0	0	0
92	31.0	0	0	0	0	0	0	0	0
93	23.5	1 700	1 700	400	400	40	0	40	2 140
94	27.7	0	0	0	0	0	3	3	3
95	32.0	0	0	0	0	0	0	0	0
96	19.2	0	0	0	0	0	0	0	0
97	37.8	0	0	150	150	0	0	0	150
98	28.8	0	0	0	0	0	0	0	0
99	26.4	0	0	0	0	0	0	0	0
100	9.4	0	0	0	0	0	0	0	0
101	22.0	0	0	0	0	0	0	0	0
102	33.7	0	0	0	0	0	0	0	0
103	39.1	0	0	0	0	0	0	0	0
104	30.6	0	0	0	0	0	0	0	0
105	9.8	0	0	0	0	0	0	0	0
106	38.8	0	0	0	0	0	0	0	0
Total	513.8	1 700	1 700	550	550	160	3	163	2 413

Table 11.16
Principal habitats in survey sectors in Map 11.7 (Argentina-7)

Sector no.	Habitat description
87	Gravel beach / rolling open scrub, salt pans
88	Gravel beach / flat open scrub
89	Gravel beach / flat open scrub
90	Saltwater estuary; rocky headlands, *restinga*, sand and gravel beaches / rolling open scrub
91	Rocky points, sand beaches / cliffs / grassland
92	Sand beach, low rocky headlands / grassland, some marsh
93	Sand and gravel beach, rocky points, some *restinga* / grassland
94	Sand and gravel beach, rocky points / grassland
95	Gravel beach / stony desert
96	Gravel beach / stony desert, dunes
97	Gravel beach / grassland, salt pans
98	Gravel beach / grassland, dunes
99	Gravel beach / grassland
100	Gravel beach, cliffs / grassland
101	Sand and gravel beach / eroding cliffs / grassland
102	Cliffs, some gravel beaches / grassland
103	Gravel beaches / cliffs / grassland
104	Gravel beaches / cliffs / grassland
105	Gravel beach around estuary / grassland
106	Cliffs, some gravel beaches / grassland

representing 5.8, 6.6, and 17.9% of the South American, Atlantic Coast, and Argentinian totals, respectively (Table 11.19).

Between Bahia San Sebastian and Cabo Domingo (Sectors 121 and 122), the coast is nearly all shingle beach backed by grassland, with an intertidal zone consisting of sandflats (Table 11.20). The area contained almost no Nearctic shorebirds.

Much of the coastline from Cabo Domingo to Cabo San Diego is rocky, and all sectors had extensive areas of *restingas*, which were particularly wide and well developed in the area of Rio Grande (Sector 123; Table 11.20). Sand and gravel beaches are found at the top of the *restingas* along much of the coast. The northern sectors were backed by extensive grassland, whereas cliffs and forests of beech (*Nothofagus* spp.) were found along much of the central Atlantic coast, giving way to boggy tableland in the southern sectors.

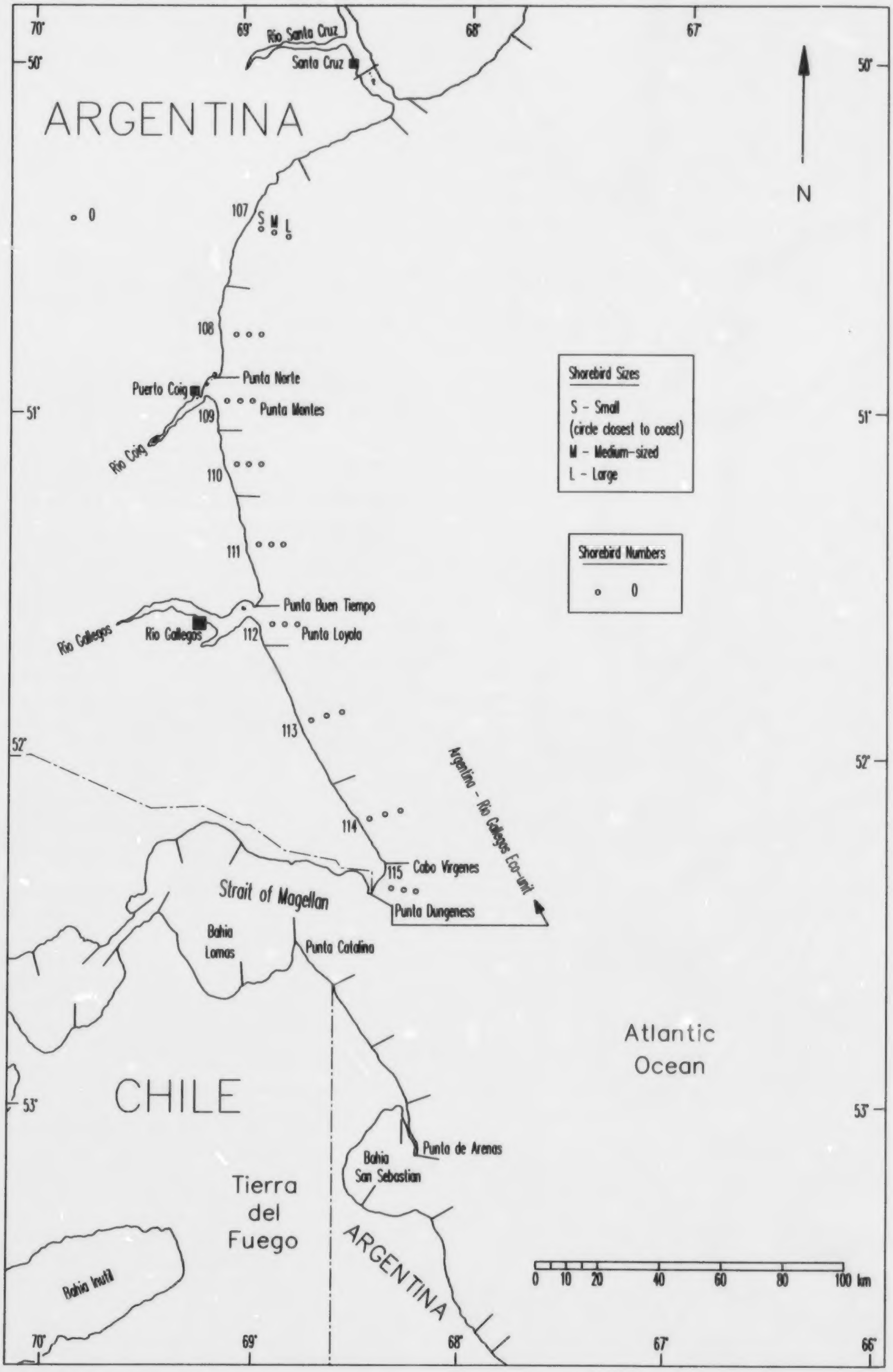
Peeps, consisting mostly of White-rumped Sandpipers, were scattered fairly regularly along the remaining Atlantic coast, with an overall total of 8500 in Sectors 123–133 and totals of 1000–2000 in Sectors 128–130. Many were encountered on rocky, reefy areas of shore, some on sandflats near such areas, and the birds appeared to use gravel beaches for roosting. The total for the Tierra del Fuego eco-unit of 23 300 small shorebirds represented 58.8 and 32.9% of the Argentinian and Atlantic Coast totals for this category, respectively (Table 11.19). When the 11 200 birds found in the Chilean sectors of the area are included (see Table 12.3), the Tierra del Fuego/Strait of Magellan area accounted for 48.7% of the regional Atlantic Coast total.

Important concentrations of Red Knots were found along the Atlantic coast of Tierra del Fuego. The area in the vicinity of Rio Grande (Sector 123) was particularly important, with 5100 birds, and a further 900 were observed near Estancia Viamonte (Sector 125). The eco-unit total of 10 500 represented 42.2% of the Argentinian total and 13.7% of the South American total (Table 11.19). The most important individual wintering area for Red Knots discovered on the surveys was at Bahia Lomas (41 700 knots; see Table 12.3); when the totals for this and other areas in the Tierra del Fuego/Strait of Magellan area are combined, the area accounted for 53 200 knots, representing 78.8 and 69.7% of the Atlantic Coast and South American totals, respectively.

Sanderlings were found principally in two locations —along the ocean beach at Peninsula El Paramo at Bahia San Sebastian (Sector 118; 340), and at Rio Grande (Sector 123; 150); the eco-unit total of 500 represented 27.3% of the Argentinian total and 5.4% of the Atlantic Coast total (Table 11.19).

Other Nearctic shorebirds observed included 13 Whimbrels in Sectors 126 and 127 and a Ruddy Turnstone in Sector 130 (Table 11.19).

Map 11.8 (Argentina-8)
Distribution of Nearctic shorebirds along the Rio Gallegos coast of Argentina



ARGENTINA
CHILE
ARGENTINA
Tierra del Fuego
Atlantic Ocean
N
Rio Santa Cruz
Santa Cruz
Puerto Coig
Punta Norte
Punta Montes
Rio Coig
Punta Buen Tiempo
Rio Gallegos
Rio Gallegos
Punta Loyola
Cabo Virgenes
Punta Dungeness
Strait of Magellan
Bahia Lomas
Punta Catalina
Bahia San Sebastian
Punta de Arenas
Bahia Inutil
Argentina - Rio Gallegos Eco-unit
107
108
109
110
111
112
113
114
115
S M L
0
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
○ 0
0 10 20 40 60 80 100 km
70°
69°
68°
67°
66°
50°
51°
52°
53°

Table 11.17
Totals of Nearctic shorebirds in survey sectors in Map 11.8 (Argentina-8)

Sector no.	Sector length (km)	Total small shorebirds	Total medium-sized shorebirds	Total large shorebirds	Total shorebirds
107	32.4	0	0	0	0
108	39.2	0	0	0	0
109	17.3	0	0	0	0
110	34.3	0	0	0	0
111	28.0	0	0	0	0
112	17.3	0	0	0	0
113	36.9	0	0	0	0
114	38.7	0	0	0	0
115	13.0	0	0	0	0
Total	257.1	0	0	0	0

Table 11.18
Principal habitats in survey sectors in Map 11.8 (Argentina-8)

Sector no.	Habitat description
107	Gravel beach / cliffs / grassland
108	Gravel beaches, some cliffs / scrubby grassland
109	Small estuary with gravel beach / cliffs / scrubby grassland
110	Gravel beach / eroding cliffs / scrubby grassland
111	Sand beach / eroding cliffs / scrubby grassland
112	Brackish estuary; salt marsh, mudflats, gravel beach / scrubby grassland
113	Gravel and sand beach / scrubby grassland, ponds behind beach
114	Sand and gravel beaches, kelp beds, small mudflats / cliffs / grassland, marshes
115	Sand beach, kelp beds / grassland

Map 11.9 (Argentina-9)
Distribution of Nearctic shorebirds along the coast of Argentinian Tierra del Fuego

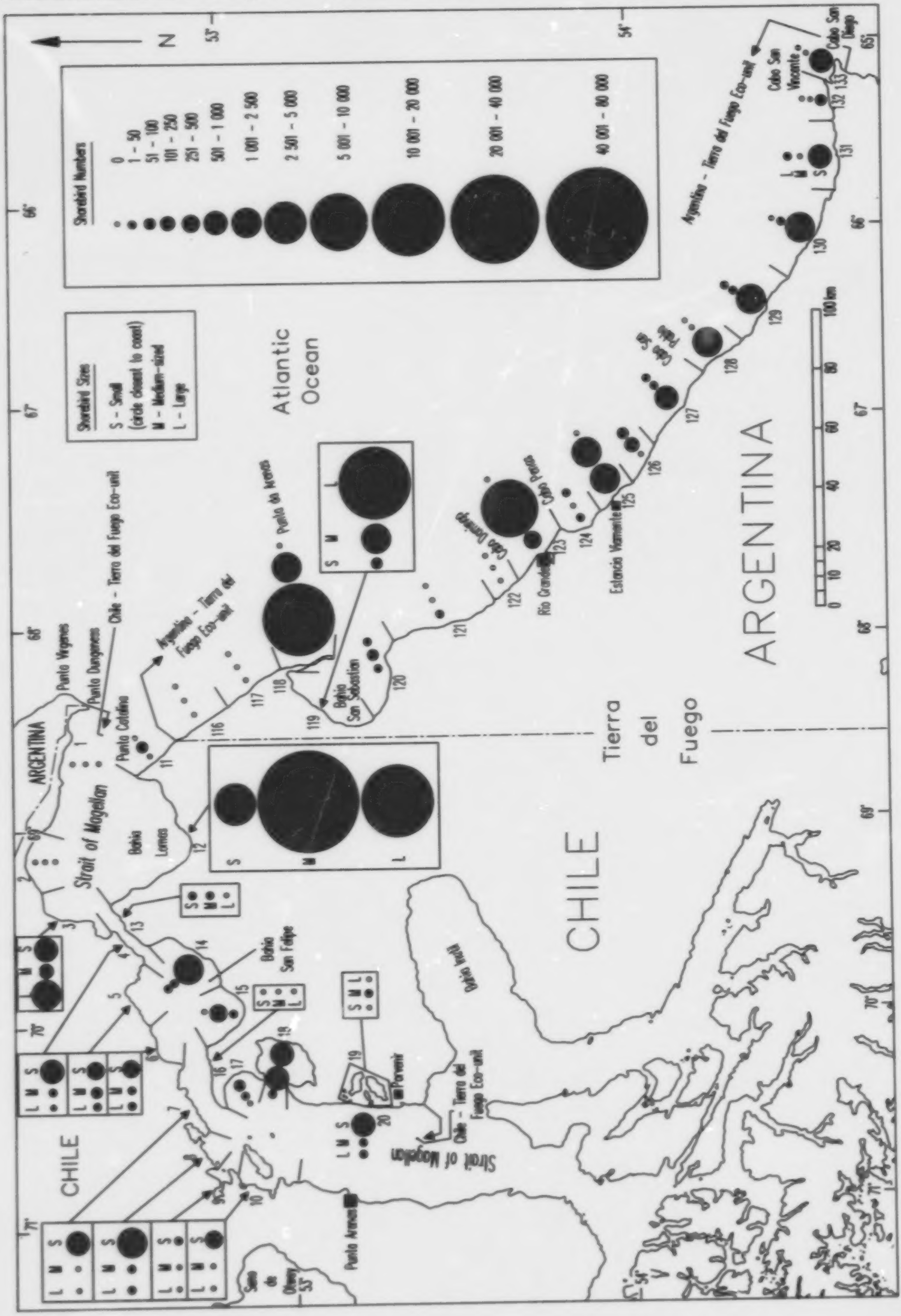

N
53°
54°
66°
67°
68°
69°
70°
71°
65°
Shorebird Numbers
0
1 – 50
51 – 100
101 – 250
251 – 500
501 – 1 000
1 001 – 2 500
2 501 – 5 000
5 001 – 10 000
10 001 – 20 000
20 001 – 40 000
40 001 – 80 000
Shorebird Sizes
S – Small
(circle closest to coast)
M – Medium-sized
L – Large
Atlantic Ocean
ARGENTINA
CHILE
Tierra del Fuego
Strait of Magellan
Bahia Lomas
Bahia San Felipe
Bahia Inutil
Bahia San Sebastian
Punta Virgenes
Punta Dungeness
Punta Catalina
Punta de Arenas
Cabo Domingo
Cabo Penas
Rio Grande
Estancia Viamonte
Cabo San Vicente
Cabo San Diego
Porvenir
Punta Arenas
Seno de Otway
Chile – Tierra del Fuego Eco-unit
Argentina – Tierra del Fuego Eco-unit
S
M
L
0 10 20 40 60 80 100 km
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133

Table 11.19
Totals of Nearctic shorebirds in survey sectors in Map 11.9 (Argentina-9)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Ruddy Turnstone	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Hudsonian Godwit	Total large shorebirds	Total shorebirds
116	24.0	0	0	0	0	0	0	0	0	0	0	0
117	18.3	0	0	0	0	0	0	0	0	0	0	0
118	31.4	340	14 700	15 040	0	2 140	0	2 140	0	0	0	17 180
119	49.1	0	100	100	0	2 200	0	2 200	0	19 340	19 340	21 640
120	21.2	10	0	10	0	100	0	100	0	50	50	160
121	39.2	2	0	2	0	0	0	0	0	0	0	2
122	7.2	0	0	0	0	0	0	0	0	0	0	0
123	26.8	150	250	400	0	5 100	30	5 130	0	0	0	5 530
124	15.6	0	20	20	0	0	0	0	0	20	20	40
125	13.6	0	1 020	1 020	0	900	800	1 700	0	0	0	2 720
126	12.5	0	0	0	0	0	250	250	1	50	51	301
127	35.3	0	730	730	0	0	40	40	12	0	12	782
128	15.3	0	2 000	2 000	0	0	0	0	0	0	0	2 000
129	27.4	0	1 170	1 170	0	30	0	30	0	12	12	1 212
130	36.8	0	1 765	1 765	1	0	0	1	0	0	0	1 766
131	22.4	2	825	827	0	0	0	0	1	0	1	828
132	15.2	0	100	100	0	0	0	0	0	0	0	100
133	18.7	0	579	579	0	0	0	0	0	0	0	579
Total	430.0	504	23 259	23 763	1	10 470	1 120	11 591	14	19 472	19 486	54 840

Table 11.20
Principal habitats in survey sectors in Map 11.9 (Argentina-9)

Sector no.	Habitat description
116	Sand and rocky beaches / cliffs / grassland plateau
117	Sand and rocky beaches / cliffs / grassland
118	Gravel beach and spit / grassland
119	Broad channelled mudflat backed by dried mud / grassland
120	Mudflat, gravel beaches / low cliffs / grassland
121	Sandflat, sand and gravel beaches / grassland
122	Sandflat, sand and gravel beaches / some cliffs / grassland
123	*Restinga*, sand and gravel beach / grassland, habitations
124	*Restinga*, gravel and sand beaches / grassland, lagoons
125	*Restinga*, gravel and sand beaches / grassland
126	*Restinga*, gravel and sand beaches / rocky headlands and cliffs / forest
127	*Restinga*, sand and gravel beach / rocky headlands and cliffs / grassland
128	*Restinga*, sand beaches / cliffs with forest, grassy tableland
129	*Restinga* and sandflats, gravel beaches / rocky headlands / grassland, forest
130	Sandflats and *restinga*, gravel beaches / rocky headlands / boggy tableland, forests
131	Sandflats and *restinga* / boggy tableland, lakes
132	*Restinga*, sandy bays with low rocky headlands / scrubby shore, bog, forest
133	*Restinga*, rocky shore / low cliffs / forest

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Chapter 12

Chile

R.I.G. Morrison, R.K. Ross, C. Downes, and A. Palma I.

12.1. General geography

Chile is a narrow, elongate country of some 756 946 km^2 occupying the southern section of the Pacific coast of South America; it extends from tropical latitudes near the Peruvian border (18°20′ S) to Cabo de Hornos (56°00′S), Tierra del Fuego, in the sub-Antarctic (Fig. 12.1). The coastline is some 4200 km long, about 90% of which is cliffed and rocky.

Throughout most of its length, the physiography of Chile is dominated by the Andes mountain system. The country may be divided into three major geotectonic units that run north–south: the Coastal Cordillera on the west coast, the Longitudinal Valley, and, to the east, the High Cordillera. The High Cordillera, known as the Principal Cordillera in the north, stretches from about 28°S, from the high plateau of the Puna de Atacama, south to 47°S, where it becomes known as the Patagonian Cordillera and continues, eventually swinging eastwards, to the eastern tip of Tierra del Fuego.

The Longitudinal Valley discontinuously divides the west and east ranges. In the north, it consists of a flat depression known as the Pampa del Tamarugal. The valley is outlined by a fault line that generally runs parallel to the coast, but which turns at its northern end to meet the Pacific coast just south of Arica. In the central part of Chile, the fault runs southward outlining the Central Valley, continuing to the gulfs of Reloncavi, Ancud, and Corcovado. South of this area the fault continues along the Moraleda Canal, turning westward into the Pacific at the Golfo de Penas.

The Coastal Cordillera begins south of Arica, where the Longitudinal Valley reaches the sea, and runs along the coast to the Golfo de Ancud. At Ancud, it is cut by a submerged glacial valley, before continuing through Chiloe Island to the Archipielago de los Chonos, ending at the Peninsula de Taitao.

Chile may be divided into several major physiographic zones based on the above characteristics (Koster 1975):

(1) *El Norte Grande* (The Far North), running from the border with Peru (18°S) to the valley of the Rio Copiapo (27°S). The coastline is extremely arid and precipitous, with the coastal range and Atacama Desert forming the shoreline.

(2) *El Norte Chico* (The Near North), extending from the Rio Copiapo to the valley of the Rio Aconcagua (33°S). The coast is generally mountainous, although terraces occur, and the climate becomes semiarid in the southern part.

(3) *La Zona Central* (The Central Zone), from the Rio Aconcagua to the Rio Bio-Bio (37–38°S). The coastal range decreases in altitude and continuity south of the Rio Aconcagua, and the coastline consists of cliffs, bluffs, and sandy bays. Dunes occur in places, and progradation of sandy coastlines has occurred in several locations (Araya-Vergara 1985).

(4) *El Sur Chico* (The Near South), from the Rio Bio-Bio to the Channel of Chacao (42°S), separating Chiloe Island and the mainland. The coastline is a mixture of steep rocky sections, with lower sandy stretches in which dunes occur. The climate changes dramatically, with greatly increased precipitation towards the south.

(5) *El Sur Grande* (The Far South), from 42°S to the southern end of the continent. From Chiloe southwards, the partly submerged mountain ranges form a deeply indented and steep fjord coastline. Tierra del Fuego includes the archipelago lying south of the Strait of Magellan between 52 and 56°S and separated from the mainland by 4–30 km. Tierra del Fuego covers 66 000 km^2, with Isla Grande being the largest (48 000 km^2) of the more than 200 islands of the archipelago (Moore 1983). The coasts of the islands descend steeply to the ocean and are broken by a few bays with sand or cobble beaches (Flint and Fidalgo 1969). The south and west ridges of the cordillera, which continues through the archipelago, are cut by straits and fjords. Tierra del Fuego is separated from the Antarctic Peninsula by the Drake Passage.

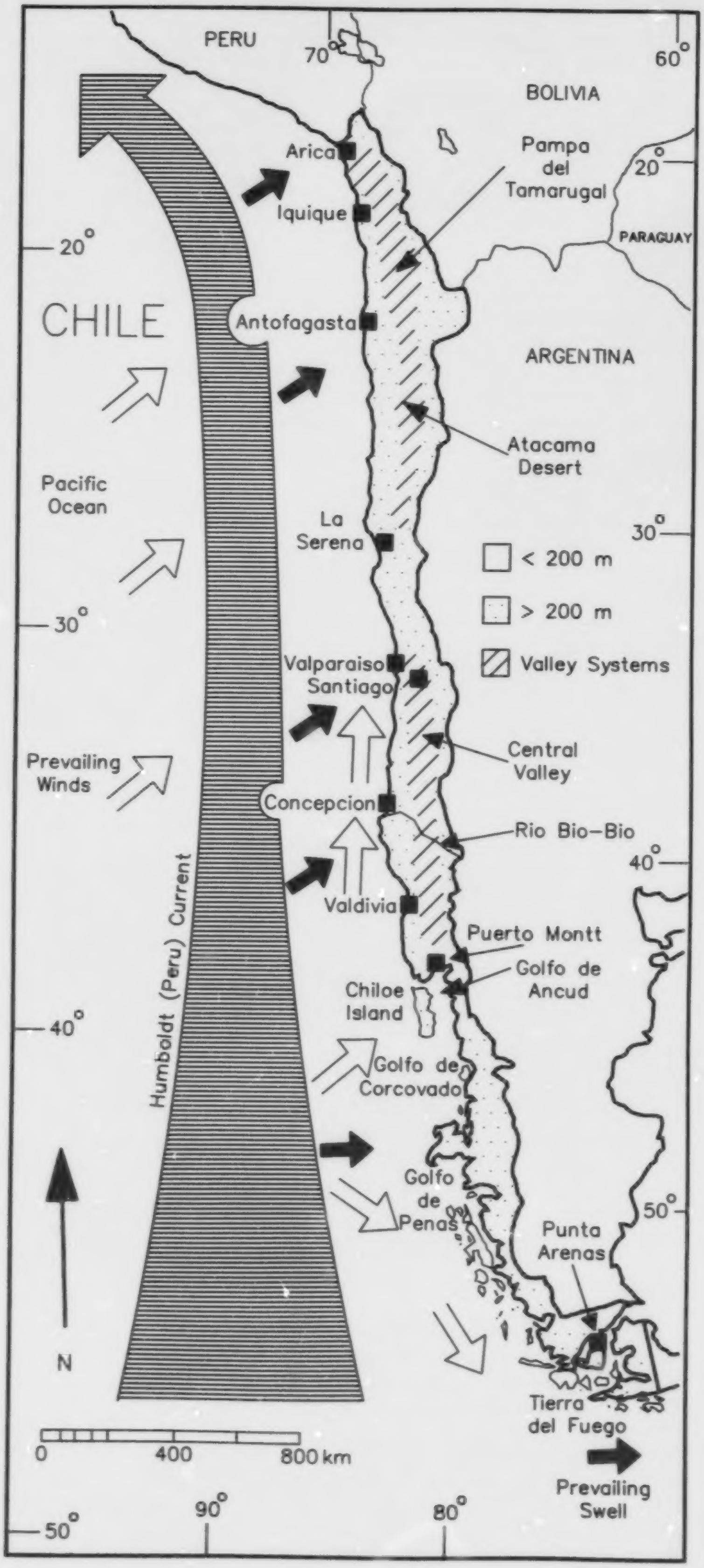
A slightly different physiographic division has been outlined by Munoz Cristi (1956) and Aguirre (1960, 1985).

Descriptive summaries of the geology of Chile include those of Bruggen (1934, 1950), Munoz Cristi (1950, 1956), Fuenzalida (1950), and, more recently, Morrison (1962) and Zeil (1964).

The climate of Chile is dominated by the Andean Cordillera and the Pacific Ocean and varies from the extremely arid desert coastlines in the north to the wet rain-forest regions of the south. Precipitation varies from less than 1 mm·yr^{-1} in the north to between 2000 and 5000 mm·yr^{-1} in the south. Mean annual temperatures range from about 19°C in the north to 5°C in the south (Miller 1976).

Westerly winds prevail south of 30°S, whereas from 30°S north to the Peru border there are mainly cool southerly to southwesterly winds along the entire coast. Southwesterly sea breezes may create short steep waves or an oceanic swell, which produces violent seas, and this is a major factor controlling the width of the intertidal zone (Stephenson and Stephenson 1972). The predominant onshore wave direction is from the southwest.

Figure 12.1
Some of the main geographical features of Chile


PERU
70°
60°
BOLIVIA
Arica
Pampa del Tamarugal
20°
Iquique
PARAGUAY
20°
CHILE
Antofagasta
ARGENTINA
Atacama Desert
Pacific Ocean
La Serena
30°
< 200 m
> 200 m
Valley Systems
30°
Valparaiso
Santiago
Central Valley
Prevailing Winds
Concepcion
Rio Bio–Bio
40°
Humboldt (Peru) Current
Valdivia
Puerto Montt
Golfo de Ancud
Chiloe Island
40°
Golfo de Corcovado
Golfo de Penas
50°
Punta Arenas
N
Tierra del Fuego
0
400
800 km
Prevailing Swell
90°
80°
50°

The coast of Chile is washed by the cold north-flowing waters of the Peru (Humboldt) Current. This current is a wind-driven stream of surface water originating in the Pacific Ocean north of Antarctica. It consists of two parts: the cold coastal current flowing in a 240-km-wide area offshore, and the warmer oceanic current 800–950 km from the coast (US Naval Hydrographic Office 1968). The colder waters of the coastal current are caused by the upwelling of deeper waters.

12.2. Shorebird distribution

The total of some 127 600 Nearctic shorebirds counted during the surveys in Chile in January 1985 included 51 200 (40.1%) small shorebirds, 44 400 medium-sized shorebirds (34.8%), and 32 000 large shorebirds (Table 12.1). The overall total represented 4.4% of the South American total, with totals for the small, medium-sized, and large categories representing 2.2, 9.7, and 26.4% of the continental totals for these categories, respectively.

The most significant areas overall for shorebirds were in the south of the country, especially in the far south in Tierra del Fuego and on the Pacific coast around Chiloe Island. The Tierra del Fuego eco-unit held 66 200 or 51.9% of the Nearctic shorebirds counted in Chile, a total representing 32.5% of the shorebirds on the Atlantic coast of the continent. The Chilean sector of Tierra del Fuego held 42 800 Red Knots *Calidris canutus*, accounting for 56.0% of the entire wintering population in South America; the majority of these birds (41 700, 97.5%) were found at a single site, Bahia Lomas, at the eastern end of the Strait of Magellan (Table 12.2*b*). Bahia Lomas was also a very important wintering site for Hudsonian Godwits *Limosa haemastica*, holding 10 500 of the total of 11 700 in Chilean Tierra del Fuego; the eco-unit total represented 25.6% of the entire South American wintering population (Table 12.2*c*). Tierra del Fuego also supported large numbers of small species, the total of 11 200 consisting principally (99.8%) of small sandpipers, or peeps, mostly White-rumped Sandpipers *Calidris fuscicollis* (Table 12.2*a*).

The Chiloe eco-unit was especially important for small and large shorebirds. Among the small species, both small sandpipers (9000) and Sanderlings *Calidris alba* (10 200) were numerous, the totals for the two representing 15.4 and 10.4%, respectively, of the regional Pacific Coast totals (Table 12.2*a*). The Chiloe area was particularly important for Hudsonian Godwits *Limosa haemastica* and Whimbrels *Numenius phaeopus* and was one of the principal centres of concentrations for both species, not only on the Pacific coast, but in all of South America. The 12 600 Hudsonian Godwits represented 98.7% of the Pacific Coast total and 27.8% of the South American total, and the 6200 Whimbrels represented 66.0 and 25.0% of the same respective totals, demonstrating that the area is of major international importance (Table 12.2*c*).

The most numerous shorebird on the Pacific coast from Chiloe to the border with Peru was the Sanderling. This species accounted for 92–100% of the small species in eco-units along the Pacific coast. Outside the Chiloe eco-unit (10 200 birds), Sanderlings reached peak numbers in the Valparaiso eco-unit, becoming somewhat less numerous towards the north of the country: the overall total of 30 300 represented 27.1% of the South American total. No peeps were recorded north of the Valparaiso eco-unit on the coast of Chile (Table 12.2*a*).

The Whimbrel was one of the few species of Nearctic shorebird to be recorded in moderately significant concentrations on the ocean beaches of Chile, with numbers becoming progressively smaller towards the north of the country. Chile held 7700 Whimbrels overall, representing 31.0% of the South American total (Table 12.2*c*).

Among the medium-sized species, yellowlegs *Tringa* spp. were observed in small numbers along the coast, mostly in wetland areas near the shore, becoming less numerous along the arid desert coasts in the north of the country. Black-bellied Plovers *Pluvialis squatarola* and Lesser Golden-Plovers *P. dominica* were not observed in southern Chile, making their appearance in small numbers towards the north of the country. Ruddy Turnstones *Arenaria interpres* and Surfbirds *Aphriza virgata* were also seen in small numbers, again more frequently in the northern parts of Chile. No Red Knots *Calidris canutus* were observed on the Pacific coast of Chile (Table 12.2*b*).

The two Willets *Catoptrophorus semipalmatus* observed in the Antofagasta eco-unit were the most southerly sightings of this species on the Pacific coast of South America.

12.3. Southern Chile

The southern Chilean region includes the areas known as Sur and Extremo Sur, extending from 36°S near Concepcion to the far southern end of the continent. Surveys were carried out in two eco-units within this geographical region—in the Chiloe area around the coasts of the island of Chiloe and adjacent mainland shores, and in Tierra del Fuego along the shores of the Strait of Magellan.

12.3.1. Geography and geomorphology

From Chiloe southwards, the coastline maintains its north–south alignment to about 50°S, where it begins an eastward curve, terminating at Cabo de Hornos at 56°S. The geographical configuration of southern Chile is different from that of the rest of the country, with the three distinct geotectonic units of the northern part of the country changing to one indistinct range of more isolated mountain peaks. The Coastal Cordillera is separated from the mainland by widespread recent subsidence and continues as an archipelago in which the former mountains have been converted to islands by transverse channels running westward to the Pacific (Gregory 1913).

Chiloe Island, the largest and most northern of these islands, retains many of the features of the northern coastline. Its western shore is roughly a straight line, whereas the eastern shore is broken into fjords. The Coastal Cordillera continues between Chiloe and the Taitao Peninsula by the Archipielago de los Chonos in which, unlike Chiloe, the western side is the less regular. Terraces lying about 35–50 m above sea level are found along the fjord at Castro on Chiloe Island. Estuaries are located at the mouth of the Rio Gamboa at the head of the fjord at Castro and to the east of Castro. Sediments are transported to the estuaries by the rivers and moved to the beach at high tide. In the vicinity of Ancud, the topography is characterized by a range of low hills, formed by volcanic rocks and rounded by erosion. The hills begin near Rio Pudeto and rise to 70–80 m, dropping steeply along the coast. Beach deposits are largely gravel and sand eroded from the hills.

Table 12.1
Summary totals of Nearctic shorebirds in eco-units in Chile

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Tierra del Fuego	619.2				
No. of birds		11 210	43 206	11 779	66 195
% of size-class total (Chile)		21.9	97.2	36.8	51.9
% of species total (South America)		0.48	9.45	9.71	2.27
% of size-class total (Atlantic Coast)		13.61	49.27	35.52	32.54
% of grand total (Atlantic Coast)		5.51	21.24	5.79	32.54
Chiloe	1 432.0				
No. of birds		19 164	789	18 856	38 809
% of size-class total (Chile)		37.4	1.8	58.9	30.4
% of species total (South America)		0.82	0.17	15.54	1.33
% of size-class total (Pacific Coast)		12.23	2.30	68.62	17.77
% of grand total (Pacific Coast)		8.77	0.36	8.63	17.77
Concepcion	880.7				
No. of birds		4 563	51	617	5 231
% of size-class total (Chile)		8.9	0.1	1.9	4.1
% of species total (South America)		0.20	0.01	0.51	0.18
% of size-class total (Pacific Coast)		2.91	0.15	2.25	2.39
% of grand total (Pacific Coast)		2.09	0.02	0.28	2.39
Valparaiso	543.0				
No. of birds		9 166	87	384	9 637
% of size-class total (Chile)		17.9	0.2	1.2	7.6
% of species total (South America)		0.39	0.02	0.32	0.33
% of size-class total (Pacific Coast)		5.85	0.25	1.40	4.41
% of grand total (Pacific Coast)		4.20	0.04	0.18	4.41
La Serena	846.2				
No. of birds		4 395	108	291	4 794
% of size-class total (Chile)		8.6	0.2	0.9	3.8
% of species total (South America)		0.19	0.02	0.24	0.16
% of size-class total (Pacific Coast)		2.81	0.31	1.06	2.19
% of grand total (Pacific Coast)		2.01	0.05	0.13	2.19
Antofagasta	582.8				
No. of birds		1 327	128	33	1 488
% of size-class total (Chile)		2.6	0.3	0.1	1.2
% of species total (South America)		0.06	0.03	0.03	0.05
% of size-class total (Pacific Coast)		0.85	0.37	0.12	0.68
% of grand total (Pacific Coast)		0.61	0.06	0.02	0.68
Arica	583.6				
No. of birds		1 361	63	59	1 483
% of size-class total (Chile)		2.7	0.1	0.2	1.2
% of species total (South America)		0.06	0.01	0.05	0.05
% of size-class total (Pacific Coast)		0.87	0.18	0.21	0.68
% of grand total (Pacific Coast)		0.62	0.03	0.03	0.68
All Chile	5 487.5				
No. of birds		51 186	44 432	32 019	127 637
% of size-class total (South America)		2.20	9.72	26.39	4.37
% of grand total (South America)		1.75	1.52	1.10	4.37

In the south, the Andes chain runs along the coast. The southern part of the mainland has been partially submerged, producing a coast that is indented with deep, steep-sided fjords, inlets, and long inland waterways. Glaciers reach the Pacific at the head of many of these fjords. In some areas, the shoreline has advanced locally toward the sea as a result of the deposition of sediment from glacial drift and glaciofluvial deposits (Bird 1985). Lobes of glaciofluvial sediment have formed in front of melting glaciers behind Chiloe Island, in Skyring Sound and Otway Sound, and on the south of Navarino Island (Araya-Vergara 1985). Cobble-strewn pocket beaches exist only in sheltered areas (Psuty and Mizobe 1982). Several discontinuous, poorly preserved terraces exist (Fuenzalida *et al.* 1965), although characteristics of the coastline appear to be principally the result of glaciation (Psuty and Mizobe 1982). Deltas occur at the head of many fjords and are partly intertidal and sometimes marshy (Araya-Vergara 1985). In general, however, the fjord coast of southern Chile appears to hold relatively little shorebird habitat; owing to the logistical problems of distance and weather, no surveys were carried out in this region.

The northern part of Isla Grande in Tierra del Fuego is relatively flat, and extensive intertidal flats have developed around Bahia Lomas. Rockier intertidal areas line much of the shoreline of the Strait of Magellan, and surveys were carried out principally in these areas. Isla Grande is traversed by the Rio del Oro, running into Bahia San Felipe, and the Rio Grande, running into the Atlantic (Moore 1983). Throughout the outer archipelago, the terrain is rugged and the islands are bounded by steep, rocky coasts cut by deep fjords. The south and west coasts are exposed to heavy wave action from the Pacific and are particularly rugged (Moore 1983); no shorebird surveys were conducted in these areas.

12.3.2. Climate

The climate of the south is cold and stormy, with heavy rains throughout the year. Strong westerly winds, which blow continuously throughout the year, predomi-

Table 12.2a
Totals of Nearctic shorebird species in eco-units in Chile—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds
Tierra del Fuego	619.2			
No. of birds		25	11 185	11 210
% of species total (Atlantic Coast)		0.27	15.83	13.61
% of species total (South America)		0.02	0.51	0.48
% of size-class total (Atlantic Coast)		0.03	13.58	13.61
% of grand total (Atlantic Coast)		0.01	5.50	5.51
Chiloe	1 432.0			
No. of birds		10 194	8 970	19 164
% of species total (Pacific Coast)		10.38	15.35	12.23
% of species total (South America)		9.12	0.41	0.82
% of size-class total (Pacific Coast)		6.51	5.73	12.23
% of grand total (Pacific Coast)		4.67	4.11	8.77
Concepcion	880.7			
No. of birds		4 543	20	4 563
% of species total (Pacific Coast)		4.63	0.03	2.91
% of species total (South America)		4.06	0.00	0.20
% of size-class total (Pacific Coast)		2.90	0.01	2.91
% of grand total (Pacific Coast)		2.08	0.01	2.09
Valparaiso	543.0			
No. of birds		8 442	724	9 166
% of species total (Pacific Coast)		8.60	1.24	5.85
% of species total (South America)		7.55	0.03	0.39
% of size-class total (Pacific Coast)		5.39	0.46	5.85
% of grand total (Pacific Coast)		3.86	0.33	4.20
La Serena	846.2			
No. of birds		4 395	0	4 395
% of species total (Pacific Coast)		4.48	0.00	2.81
% of species total (South America)		3.93	0.00	0.19
% of size-class total (Pacific Coast)		2.81	0.00	2.81
% of grand total (Pacific Coast)		2.01	0.00	2.01
Antofagasta	582.8			
No. of birds		1 327	0	1 327
% of species total (Pacific Coast)		1.35	0.00	0.85
% of species total (South America)		1.19	0.00	0.06
% of size-class total (Pacific Coast)		0.85	0.00	0.85
% of grand total (Pacific Coast)		0.61	0.00	0.61
Arica	583.6			
No. of birds		1 361	0	1 361
% of species total (Pacific Coast)		1.39	0.00	0.87
% of species total (South America)		1.22	0.00	0.06
% of size-class total (Pacific Coast)		0.87	0.00	0.87
% of grand total (Pacific Coast)		0.62	0.00	0.62
All Chile	5 487.5			
No. of birds		30 287	20 899	51 186
% of species total (South America)		27.09	0.94	2.20
% of size-class total (South America)		1.30	0.90	2.20
% of grand total (South America)		1.04	0.72	1.75

nate (Stephenson and Stephenson 1972). South of 43°S, near the south of Chiloe Island, the influence of the Andes is the major factor controlling climatic conditions. Air from the west is forced to rise abruptly at the coast and is turned south, causing heavy rainfall over the offshore islands, with as much as 6000 mm annually between 48 and 52°S along the coast (Miller 1976).

Temperatures in southern Chile are fairly consistent throughout the year. In summer, the average temperature is 14°C south of Chiloe and about 9°C in Tierra del Fuego. During August, the coldest month of the year, temperatures average around 10°C south of Chiloe and 4°C in Tierra del Fuego (Rumney 1968).

The most characteristic features of the south Patagonian climate are the strong winds and consistent climate throughout the year. The Patagonian ice field stretches for some 500 km along the Andean Cordillera, starting south of Puerto Aisen (45°S). There are two almost continuous ice fields, one lying between 46 and 48°S and the other between 48°30′S and 51°S. Most outlet glaciers flow westwards towards the fjords of the Pacific coast (Mercer 1970). Several smaller ice fields lie to the south, leading to the large one on Tierra del Fuego, north of the Beagle Channel (Miller 1976).

The climate of Tierra del Fuego has alternated between moist and dry periods since the last ice age (16 000 years BP) and is currently in a relatively dry period (Auer 1970). Westerly winds reaching Tierra del Fuego from the Pacific Ocean result in a gradient of annual rainfall ranging from 2000–5000 $mm \cdot yr^{-1}$ in the south and west to 400 $mm \cdot yr^{-1}$ in the northeast of Isla Grande (Moore 1983). The temperature regime is strongly affected by the ocean. In January, the average temperature (9–10°C) is only slightly above that of the surrounding ocean. The average July temperature is 1.6°C at Ushuaia and 0.4°C at Rio Grande, Argentina (Schnack 1985).

Table 12.2b
Totals of Nearctic shorebird species for eco-units in Chile—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Surfbird	Yellowlegs species	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Tierra del Fuego	619.2								
No. of birds		0	0	2	0	14	42 762	428	43 206
% of species total (Atlantic Coast)		0.00	0.00	0.22	0.00	0.23	63.31	4.97	49.27
% of species total (South America)		0.00	0.00	0.01	0.00	0.02	55.98	0.23	9.45
% of size-class total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.02	48.77	0.49	49.27
% of grand total (Atlantic Coast)		0.00	0.00	0.00	0.00	0.01	21.02	0.21	21.24
Chiloe	1 432.0								
No. of birds		0	0	0	20	164	0	605	789
% of species total (Pacific Coast)		0.00	0.00	0.00	10.15	6.93	0.00	2.41	2.30
% of species total (South America)		0.00	0.00	0.00	10.15	0.18	0.00	0.33	0.17
% of size-class total (Pacific Coast)		0.00	0.00	0.00	0.06	0.48	0.00	1.76	2.30
% of grand total (Pacific Coast)		0.00	0.00	0.00	0.01	0.08	0.00	0.28	0.36
Concepcion	880.7								
No. of birds		0	0	0	0	36	0	15	51
% of species total (Pacific Coast)		0.00	0.00	0.00	0.00	1.52	0.00	0.06	0.15
% of species total (South America)		0.00	0.00	0.00	0.00	0.04	0.00	0.01	0.01
% of size-class total (Pacific Coast)		0.00	0.00	0.00	0.00	0.10	0.00	0.04	0.15
% of grand total (Pacific Coast)		0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.02
Valparaiso	543.0								
No. of birds		0	2	0	20	10	0	55	87
% of species total (Pacific Coast)		0.00	0.07	0.00	10.15	0.42	0.00	0.22	0.25
% of species total (South America)		0.00	0.01	0.00	10.15	0.01	0.00	0.03	0.02
% of size-class total (Pacific Coast)		0.00	0.01	0.00	0.06	0.03	0.00	0.16	0.25
% of grand total (Pacific Coast)		0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.04
La Serena	846.2								
No. of birds		14	4	29	61	0	0	0	108
% of species total (Pacific Coast)		93.33	0.14	1.23	30.96	0.00	0.00	0.00	0.31
% of species total (South America)		0.35	0.01	0.12	30.96	0.00	0.00	0.00	0.02
% of size-class total (Pacific Coast)		0.04	0.01	0.08	0.18	0.00	0.00	0.00	0.31
% of grand total (Pacific Coast)		0.01	0.00	0.01	0.03	0.00	0.00	0.00	0.05
Antofagasta	582.8								
No. of birds		0	0	113	15	0	0	0	128
% of species total (Pacific Coast)		0.00	0.00	4.80	7.61	0.00	0.00	0.00	0.37
% of species total (South America)		0.00	0.00	0.48	7.61	0.00	0.00	0.00	0.03
% of size-class total (Pacific Coast)		0.00	0.00	0.33	0.04	0.00	0.00	0.00	0.37
% of grand total (Pacific Coast)		0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.06
Arica	583.6								
No. of birds		1	22	6	4	0	0	30	63
% of species total (Pacific Coast)		6.67	0.77	0.25	2.03	0.00	0.00	0.12	0.18
% of species total (South America)		0.02	0.08	0.03	2.03	0.00	0.00	0.02	0.01
% of size-class total (Pacific Coast)		0.00	0.06	0.02	0.01	0.00	0.00	0.09	0.18
% of grand total (Pacific Coast)		0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.03
All Chile	5 487.5								
No. of birds		15	28	150	120	224	42 762	1 133	44 432
% of species total (South America)		0.37	0.10	0.64	60.91	0.25	55.98	0.61	9.72
% of size-class total (South America)		0.00	0.01	0.03	0.03	0.05	9.36	0.25	9.72
% of grand total (South America)		0.00	0.00	0.01	0.00	0.01	1.46	0.04	1.52

12.3.3. Vegetation

Data on the tidal marshes of the Pacific coast of temperate South America are sparse. Tidal marshes are confined to small inlets along the mountainous, high-energy coasts of southern and central Chile. Salt shrubs, especially *Spartina densiflora* and *Salicornia* spp., dominate the small tidal marshes of southern Chile (West 1977; Psuty and Mizobe 1982). Salt marshes are found at the mouths of small rivers in Patagonia.

Most of the wet coastal zone is covered by dense forests of false beech and various conifers. Moss covers many of the forest floors and is especially heavy in the southern part of Tierra del Fuego. In the south, agriculture is limited to small protected areas because of the strong winds and heavy rains.

The major coastal biotic zones of southern Chile include the Valdivian forest zone, from 37 to 48°S, the Magellanic forest zone, which covers parts of the coastline of Tierra del Fuego, and the Magellanic moorland zone, running from 48°S in the Golfo de Penas to Cabo de Hornos (Kuschel 1960).

The Valdivian forest possesses a rich diversity of species in comparison with other cold temperate areas of southern Chile, although the diversity decreases southwards. In this zone, the conditions for forest development are optimal. *Nothofagus dombeyi* and *Eucryphia cordifolia* are the main evergreen tree species. In sheltered areas along the coast, these trees can grow up to 60 m high, but in other areas the vegetation is flattened by the wind (Stephenson and Stephenson 1972). The liana *Hydrangea integernina* is abundant, and ferns are numerous. The bamboo-like *Chusquea quila* is common where disturbance occurs. Under the trees, the shrub layer is poorly developed (Heusser 1974).

Table 12.2c
Totals of Nearctic shorebird species in eco-units in Chile—
large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds
Tierra del Fuego	619.2					
No. of birds		119	0	11 660	0	11 779
% of species total (Atlantic Coast)		56.67	0.00	35.64	0.00	35.52
% of species total (South America)		0.48	0.00	25.61	0.00	9.71
% of size-class total (Atlantic Coast)		0.36	0.00	35.17	0.00	35.52
% of grand total (Atlantic Coast)		0.06	0.00	5.73	0.00	5.79
Chiloe	1 432.0					
No. of birds		6 210	0	12 642	4	18 856
% of species total (Pacific Coast)		66.01	0.00	98.67	0.66	68.62
% of species total (South America)		24.97	0.00	27.77	0.06	15.54
% of size-class total (Pacific Coast)		22.60	0.00	46.01	0.01	68.62
% of grand total (Pacific Coast)		2.84	0.00	5.79	0.00	8.63
Concepcion	880.7					
No. of birds		617	0	0	0	617
% of species total (Pacific Coast)		6.56	0.00	0.00	0.00	2.25
% of species total (South America)		2.48	0.00	0.00	0.00	0.51
% of size-class total (Pacific Coast)		2.25	0.00	0.00	0.00	2.25
% of grand total (Pacific Coast)		0.28	0.00	0.00	0.00	0.28
Valparaiso	543.0					
No. of birds		384	0	0	0	384
% of species total (Pacific Coast)		4.08	0.00	0.00	0.00	1.40
% of species total (South America)		1.54	0.00	0.00	0.00	0.32
% of size-class total (Pacific Coast)		1.40	0.00	0.00	0.00	1.40
% of grand total (Pacific Coast)		0.18	0.00	0.00	0.00	0.18
La Serena	846.2					
No. of birds		291	0	0	0	291
% of species total (Pacific Coast)		3.09	0.00	0.00	0.00	1.06
% of species total (South America)		1.17	0.00	0.00	0.00	0.24
% of size-class total (Pacific Coast)		1.06	0.00	0.00	0.00	1.06
% of grand total (Pacific Coast)		0.13	0.00	0.00	0.00	0.13
Antofagasta	582.8					
No. of birds		31	2	0	0	33
% of species total (Pacific Coast)		0.33	0.04	0.00	0.00	0.12
% of species total (South America)		0.12	0.00	0.00	0.00	0.03
% of size-class total (Pacific Coast)		0.11	0.01	0.00	0.00	0.12
% of grand total (Pacific Coast)		0.01	0.00	0.00	0.00	0.02
Arica	583.6					
No. of birds		59	0	0	0	59
% of species total (Pacific Coast)		0.63	0.00	0.00	0.00	0.21
% of species total (South America)		0.24	0.00	0.00	0.00	0.05
% of size-class total (Pacific Coast)		0.21	0.00	0.00	0.00	0.21
% of grand total (Pacific Coast)		0.03	0.00	0.00	0.00	0.03
All Chile	5 487.5					
No. of birds		7 711	2	24 302	4	32 019
% of species total (South America)		31.00	0.00	53.38	0.06	26.39
% of size-class total (South America)		6.36	0.00	20.03	0.00	26.39
% of grand total (South America)		0.26	0.00	0.83	0.00	1.10

In the Magellanic forest, only six species of tree extend into Tierra del Fuego, three of which are in the genus *Nothofagus*. The Magellanic moorland forest is extremely wet and exposed to strong winds. The soil is saturated and covered with peat, and woodland is found only in sheltered areas.

In Tierra del Fuego, temperature and rainfall gradients, and more marked seasonal differences between the south/west and the north/east, are reflected in the pattern of vegetation. Along the western edge of the archipelago, a series of bog communities, termed the Magellanic moorland, is characterized by dwarf shrubs, cushion plants, sedges, and bryophytes (Moore 1983). The evergreen forest, dominated by *Nothofagus betuloides*, characteristic of the western edge of Chile, continues east along the islands south of Isla Grande and extends to the eastern tip of Isla de los Estados (Imshaug 1972). On the south Atlantic coasts, deciduous forest occurs along both flanks of the mountains, from sea level to almost 500 m. The dominant species is *N. pumilio*, followed by *N. antarctica*. Shrub, bog, and grassland communities also occur. Much of the north and northeast coasts of Isla Grande is covered by Patagonian steppe vegetation, a grassland dominated by *Festuca* species. In areas where there is no lateral movement of the groundwater and salts can accumulate, the wet saline soils support a grassland in which *Puccinellia* species are dominant. The coastal sands in the northern section of Isla Grande support a shrub community dominated by *Lepidophyllum cupressiforme*.

12.3.4. Shorebird distribution

12.3.4.1. Tierra del Fuego eco-unit

Sectors 1–20; Map 12.1 (Chile-1)

Surveys in the Chilean Tierra del Fuego eco-unit covered both the north and south sides of the Strait of Magellan, from its eastern mouth to a line running approximately from Punta Arenas to Porvenir. The eco-

Map 12.1 (Chile-1)
Distribution of Nearctic shorebirds along the coast of Chilean Tierra del Fuego

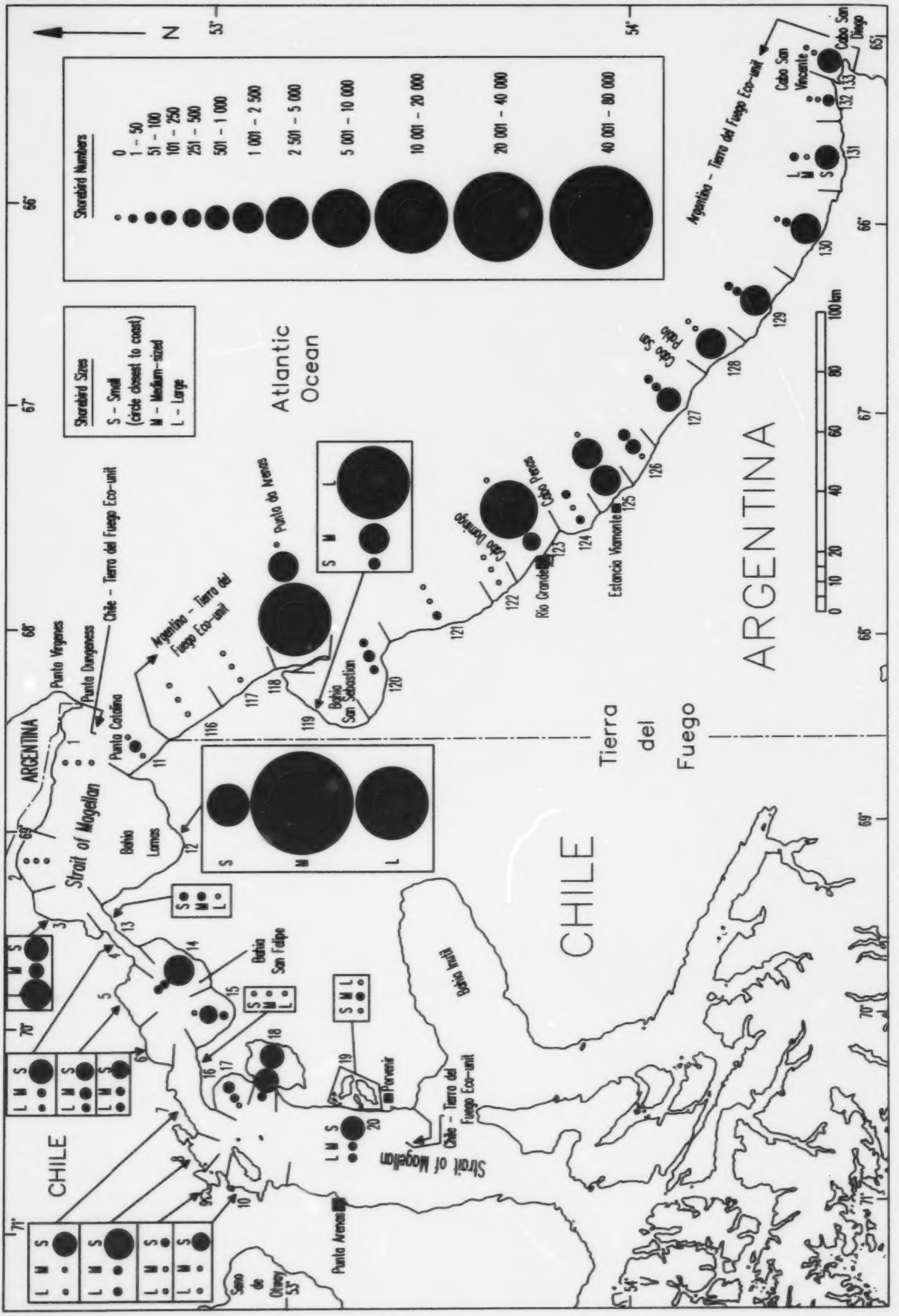

N
Shorebird Numbers
0
1 – 50
51 – 100
101 – 250
251 – 500
501 – 1 000
1 001 – 2 500
2 501 – 5 000
5 001 – 10 000
10 001 – 20 000
20 001 – 40 000
40 001 – 80 000
Shorebird Sizes
S – Small (circle closest to coast)
M – Medium-sized
L – Large
Atlantic Ocean
ARGENTINA
CHILE
Tierra del Fuego
Strait of Magellan
Bahía Lomas
Bahía San Felipe
Bahía Inútil
Bahía San Sebastián
Punta Vírgenes
Punta Dungeness
Punta Catalina
Punta de Arenas
Punta Arenas
Porvenir
Río Grande
Estancia Viamonte
Cabo Domingo
Cabo Peñas
Cabo San Pablo
Cabo San Vicente
Cabo San Diego
Seno de Otway
Chile – Tierra del Fuego Eco-unit
Argentina – Tierra del Fuego Eco-unit
S M L
53°
54°
65°
66°
67°
68°
69°
70°
71°
0 10 20 40 60 80 100 km
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133

Table 12.3
Totals of Nearctic shorebirds in survey sectors in Map 12.1 (Chile-1)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Ruddy Turnstone	Yellowlegs species	Red Knot	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Hudsonian Godwit	Total large shorebirds	Total shorebirds
1	50.0	0	0	0	0	0	0	0	0	0	0	0	0
2	24.4	0	0	0	0	0	0	0	0	0	0	0	0
3	36.6	0	970	970	0	0	210	0	210	56	1 140	1 196	2 376
4	13.1	0	531	531	0	0	0	20	20	0	0	0	551
5	30.2	25	444	469	0	0	30	50	80	3	0	3	552
6	19.6	0	314	314	0	0	0	21	21	3	0	3	338
7	27.6	0	691	691	0	0	0	0	0	0	0	0	691
8	35.2	0	1 627	1 627	0	0	0	8	8	1	0	1	1 636
9	27.5	0	32	32	0	0	0	0	0	0	0	0	32
10	7.8	0	262	262	0	0	0	0	0	0	0	0	262
11	10.0	0	0	0	0	0	100	0	100	0	0	0	100
12	69.9	0	3 720	3 720	0	0	41 700	0	41 700	20	10 520	10 540	55 960
13	19.0	0	11	11	0	0	5	0	5	0	0	0	16
14	31.6	0	1 318	1 318	0	2	10	0	12	20	0	20	1 350
15	31.0	0	5	5	0	0	0	300	300	0	0	0	305
16	22.6	0	0	0	0	0	0	0	0	0	0	0	0
17	26.4	0	91	91	0	0	5	2	7	0	0	0	98
18	53.1	0	630	630	2	0	702	20	724	11	0	11	1 365
19	31.4	0	0	0	0	10	0	0	10	0	0	0	10
20	52.2	0	539	539	0	2	0	7	9	5	0	5	553
Total	619.2	25	11 185	11 210	2	14	42 762	428	43 206	119	11 660	11 779	66 195

Table 12.4
Principal habitats in survey sectors in Map 12.1 (Chile-1)

Sector no.	Habitat description
1	Gravel beach and spit, cliffs / grassland, marsh
2	Gravel and sand beaches / some cliffs / grassland
3	Mudflats, gravel beach / grassland
4	Gravel beach / cliffs / grassland
5	Gravel beach, some saline ponds / grassland
6	Gravel beach, rocky point / grassland
7	Gravel beach, inlet with tough mudflats / low cliffs / grassland
8	Gravel points, sand and gravel beaches, inlet with tough mudflats / cliffs / grassland
9	Gravel and stony beach, marshy inlet / grassland
10	Mudflat, gravel beach / grassland
11	*Restinga*, gravel beach / grassland
12	Very broad mud- and sandflats, backed by dried mud / grassland, some small rivers
13	Sand and gravel beach / low cliffs / scrub and grassland
14	Gravel beach with sand / flat grassland
15	Gravel beach, marshy river exit / grassland
16	Gravel beach / low cliff / grassland
17	Gravel beach, some kelp beds / grassland
18	Occasional flats, rocky gravel beach / grassland
19	Inland; shallow saline lagoon, rocky shores / grassland
20	Gravel and rocky beach with kelp / some low cliffs / grassland, inland saline lagoon

unit contained areas of major international importance for shorebirds, particularly Red Knots and Hudsonian Godwits, and was also of significance for small species, particularly White-rumped Sandpipers (Table 12.3).

One of the most spectacular and important wintering areas for Nearctic shorebirds discovered during the surveys was Bahia Lomas (Sector 12), a large embayment lying on the south side of the eastern entrance to the Strait of Magellan. The bay contains an enormous area of intertidal flats, which tend to be smooth and sandy towards the edges and softer and more highly channelled towards the middle (Table 12.4). The tidal area merges gradually into a dry upper zone, which is infrequently flooded, before reaching the flat grasslands extending inland. The upper, dried-out zone is very broad, making the lower intertidal areas almost inaccessible, and it is perhaps not surprising that the presence of the large numbers of Nearctic shorebirds using the bay had remained undiscovered until the surveys. Bahia Lomas was the single most important wintering site for Red Knots in South America, the total of 41 700 representing 54.6% of the South American total. Knots appeared to be more common on the smoother flats towards the edges of the bay. Bahia Lomas was also of major importance for the Hudsonian Godwit, being the second most important individual site discovered in South America, holding 10 500 birds, or 23.1% of the South American total. Godwits appeared to be more common on the highly channelled flats towards the middle of the bay; this type of flat was especially common at Bahia San Sebastian, the most important site for godwits in South America, some 60 km to the southeast in the Argentinian sector of Tierra del Fuego. Over 3700 small shorebirds (peeps) were also found at Bahia Lomas; this was the highest sector total in the Chilean sector of Tierra del Fuego, and second only to Bahia San Sebastian on the island. Twenty Whimbrels were recorded at Bahia Lomas, and the area also supported large numbers of Kelp Gulls *Larus dominicanus*, terns, and oystercatchers (Table 12.3).

Other areas near the eastern mouth of the Strait of Magellan also supported moderately large concentrations of Nearctic shorebirds. One hundred knots were observed on the Atlantic coast south of Punta Catalina (Sector 11), near Bahia Lomas. Although the gravel and sand beaches lining the north shore of the Strait of Magellan west of Punta Dungeness did not support any shorebirds (Sectors 1 and 2), moderate numbers of peeps (970), Red Knots (210), Whimbrels (60), and Hudsonian Godwits (1100) were found in Sector 3 (Table 12.3), mostly on a series of channelled flats near the mouth of the First Narrows, in the western part of the sector across from Bahia Lomas.

Strong currents flow through the First Narrows, and both the north (Sector 4) and south (Sector 13) shores consist mostly of gravel beaches, with some sand, backed by low cliffs or hills, with grassland stretching inland. Few shorebirds were seen along these sectors, although

Bahia Lomas, Tierra del Fuego, Chile. Vast intertidal flats have built up in Bahia Lomas, occupying an indentation in the coast near the eastern mouth of the Strait of Magellan; the area was the most important wintering site for Red Knots discovered during the surveys.

500 peeps were seen on rocky sections towards the western end of the north shore (Sector 4).

The remaining sectors on the north shore (Sectors 5–10) were mostly lined with gravel beaches, in some cases backed by cliffs, with the Patagonian grassland stretching inland (Table 12.4). Sections of rocky intertidal areas occurred in some places; inlets with tough mudflats occurred in Sectors 7 and 8; and inlets with marshy zones and some flats were found in Sector 9. This mixture of habitats supported moderate numbers of peeps, ranging from 30 to 1600, and small numbers of knots and godwits. Ground observations indicated that the small shorebirds were mostly White-rumped Sandpipers, with some Rufous-chested Dotterels *Charadrius modestus* and Two-banded Plovers *C. falklandicus*.

The south shore of the Strait of Magellan (Sectors 14–20) was also lined extensively with gravel beaches; most of the shoreline was flat, with only occasional cliffs along the shore of the Second Narrows (Sector 16), and the interior consisted of grasslands stretching far inland (Table 12.4). In Sectors 14 and 15 (Bahia San Felipe), moderate numbers of peeps were found, often on small rocky points or intertidal areas below the gravel beach or in association with a river mouth. Small areas of intertidal flats, some channelled, were found in the southern part of the bay in Sector 18, and these attracted Red Knots (700), peeps (630), and Whimbrels (11). The extensive series of saline lakes and ponds behind the coast in Sector 19 north of Porvenir supported few shorebirds, with the exception of 10 yellowlegs (Table 12.3).

In summary, the shores of the Strait of Magellan, consisting mostly of gravel beaches backed by extensive grassland, supported moderate concentrations of peeps, mostly White-rumped Sandpipers, especially where small rocky intertidal areas and flats developed. The large bay system at Bahia Lomas contained enormous intertidal flats and was of major international importance for Red Knots and Hudsonian Godwits.

12.3.4.2. Chiloe eco-unit

Sectors 21–55; Map 12.2 (Chile-2)

The Chiloe area is, with Tierra del Fuego, one of the two most important centres of shorebird distribution in Chile. The bays and inlets on the north and east coasts of Chiloe Island, as well as the mainland shores near Puerto Montt and around the Golfo de Ancud, supported significant proportions of the South American populations of several shorebird species, especially the larger and smaller species. The eco-unit total of 12 600 Hudsonian Godwits represented 27.8% of the South American wintering population and 98.7% of the Pacific Coast birds. The total of 6200 Whimbrels made Chiloe the second most important area for this species in South America after the north-central coast of Brazil, the total representing 25.0% of the South American total and 66.0% of the Pacific Coast birds. Small numbers of Surfbirds and yellowlegs were seen in the region. The 10 200 Sanderlings made up the largest eco-unit total recorded in Chile, representing 10.4% of the Pacific Coast total and 9.1% of the South American total. The 9000 peeps were regionally important, representing 15.4% of the Pacific Coast total; this eco-unit total also represented 13.4% of the small species total on the southern Atlantic and Pacific coasts between southern Brazil and Chiloe (66 800), comprising the main coastal wintering range of the White-rumped Sandpiper (with smaller numbers of Baird's Sandpipers *Calidris bairdii*, Rufous-chested Dotterels, and Two-banded Plovers; Table 12.5).

The western, Pacific coast of Chiloe Island (Sectors 22–27) was similar to, although sandier than, the mainland coast of Chile to the north, consisting of a series of sand and gravel beaches, interspersed with steep rocky headlands and eroding cliffs, and backed by forested hills inland (Table 12.6). Little shorebird habitat was available apart from ocean beach, and the majority of shorebirds seen were Sanderlings, with a few Whimbrels. Occasional river entrances or wetlands behind sandy barriers did not appear to hold any concentrations of shorebirds.

The main shorebird areas were on the north and west coasts of Chiloe Island, along the north shore of the Strait of Chacao, which separates Chiloe Island from the mainland, and around the mainland coasts of the Seno de Reloncavi and the Golfo de Ancud. Hudsonian Godwits occurred regularly along the inlets of the north and east coasts of Chiloe Island, with 2000 in the bay west of Ancud (Sector 27), totals of 250–870 in Sectors 29–35 along the east coast of the island, and a further 1700 in Sector 37 towards the southeast corner of the island. Much of the coastline consisted of gravel beaches backed by hills, covered with a patchwork of agricultural fields or with uncleared forest, with narrow inlets leading back from the outer coast. Many of the inlets had a marshy delta at their heads, and it was on these areas that many of the flocks of Hudsonian Godwits and Whimbrels were found. Concentrations of Hudsonian Godwits were also found on the flats near the towns of Chonchi (Sector 33) and Quellon (Sector 37). Whimbrels were common throughout the area, sector totals ranging between about 30 and 700 birds in Sectors 27–37. Whimbrels were somewhat more dispersed than godwits, being found in small flocks along gravel beaches and points, as well as in larger roosting flocks on marshes at the heads of the coastal inlets. Other areas of particular note for Hudsonian Godwits included the inlets to the west of Puerto Montt along the north shore of the Golfo de Ancud, where 2900 birds were counted on the marshy upper deltas of inlets in Sector 53, and the broad, sandy delta just east of Puerto Montt, where flocks totalling 2100 godwits were observed. A further 570 godwits were counted in the extensive estuarine area near Maullin (Sector 55). Whimbrels were also common all along the northern part of the eco-unit, including Seno de Reloncavi, with up to 340 birds on the delta east of Puerto Montt (Sector 51), 1100 in the inlets west of Puerto Montt (Sector 53), and 740 birds in the estuary at Maullin (Table 12.5).

Sanderlings were especially numerous along the channel separating Chiloe Island and the mainland. The largest numbers were found in Sector 29 (2600) on Chiloe Island, especially on the sandflats near Caulin, along the mainland shore of the channel opposite (870) in Sector 54, and in the nearby estuary at Maullin (1000) in Sector 55. Other notable areas on Chiloe Island included the northeastern coastline in Sector 30 (1000) near Linao and the southern part of Sector 34 (1600) (Table 12.5).

Peeps also tended to be concentrated along the channel between Chiloe Island and the mainland. The largest concentrations were found in Sector 54 (4700) on the north coast of the channel, in a marshy inlet behind the shore towards the west end of the sector near Carelmapu, with a further 2300 birds in the estuary at Maullin (Sector 55), and another 1000 on the south shore of the channel in Sector 29 near Caulin.

Most yellowlegs observed in the eco-unit were in Sector 55 (130), in the estuary near Maullin. Small numbers were observed elsewhere in marshy areas or deltas (e.g., Sector 51, 12 birds; Sector 35, 10 birds; Table 12.5).

The mainland shore opposite Chiloe Island, between the Golfo de Ancud and Golfo Corcovado (Sectors 40–48), contained moderate to small numbers of shorebirds. The inner parts of the coastline consisted of steep, mountainous fjords leading back from the gulf coast and generally contained little foreshore (Table 12.6); totals of shorebirds in sectors with this type of coast were generally small (e.g., Sectors 42, 44, 46, 47, and 50). A belt of relatively low-lying land runs along much of the remaining outer coastline (e.g., Sectors 40, 41, 43, 45, 48, and 49), and these sectors contained most of the birds. Much of the coast consisted of gravel or sand beaches or rocky shore, backed by forested lowland hills or farms. Whimbrels occurred all along the coast, often on gravelly or rocky stretches, and Sanderlings were widely distributed in small numbers on sandy shores. The highest sector total occurred in Sector 43 (1400), where a lagoon/inlet area with sandflats attracted a variety of species, including Hudsonian Godwits (55), Whimbrels, yellowlegs, Sanderlings, and peeps. Surfbirds were noted on rocky sections in Sectors 43 and 45 (Table 12.5).

A change of habitat was noticeable in the southern sectors of the eco-unit, both on the mainland (Sectors 40 and 41) and on Chiloe Island (Sectors 21, 38, and 39). On the mainland, large sand and cobble beaches were backed by hillsides of wild, southern (*Nothofagus*) forest, covered with clinging curtains of moss; on Chiloe Island, large sand beaches and rocky slabs were backed by similar, impenetrable forest (Table 12.6). Some Sanderlings and peeps were observed along the mainland sectors, whereas few birds were seen along the south coast of Chiloe Island, with the exception of a river mouth estuary in Sector 21, in which flocks of Whimbrels, Hudsonian Godwits, Sanderlings, and peeps were found (total 1000 shorebirds; Table 12.5).

12.4. Central Chile

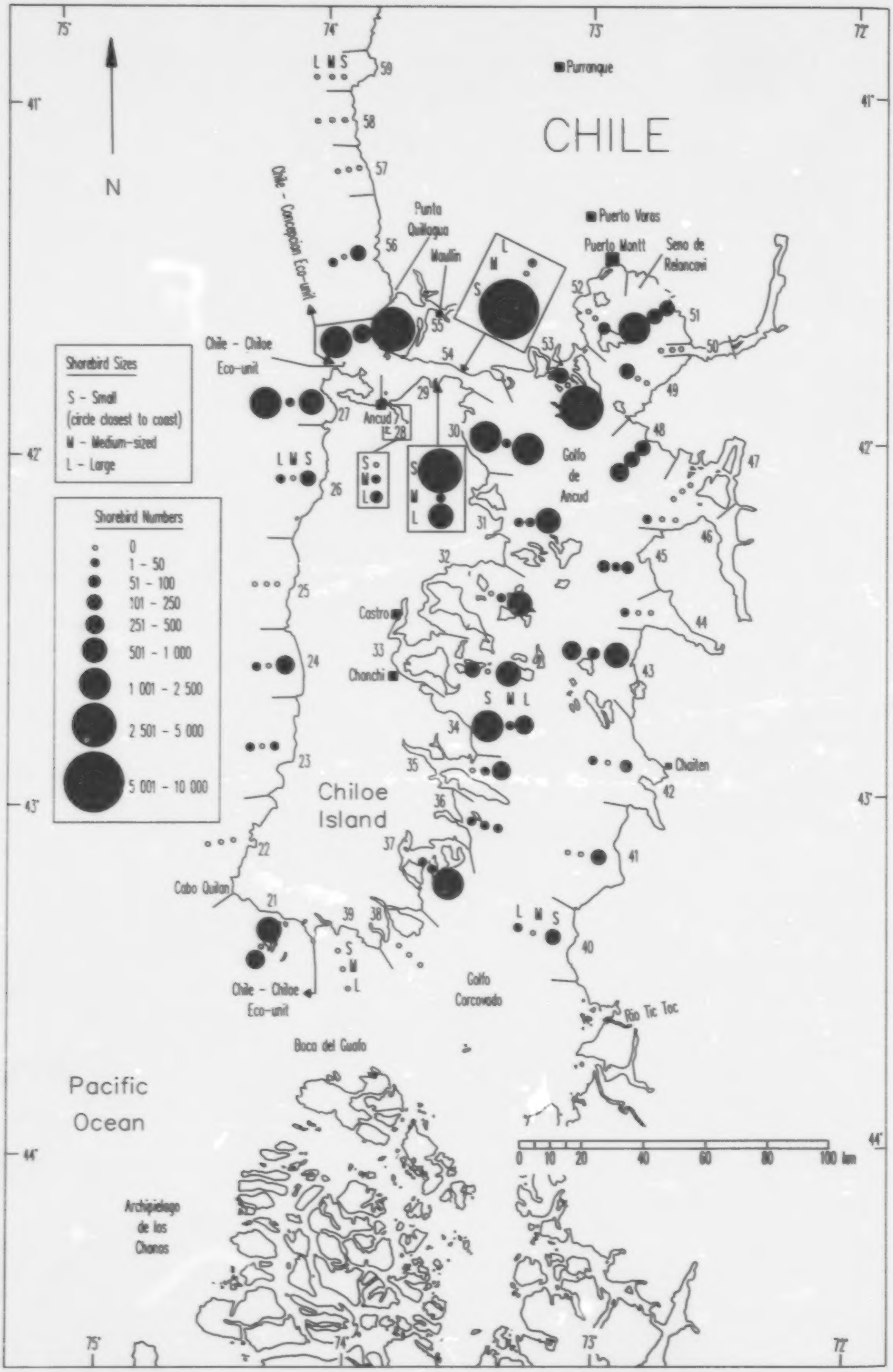
12.4.1. Geography and geomorphology

Hugging the coast of central Chile (30–42°S) is a deeply dissected range of terraced hills and plateaus, decreasing in altitude and continuity south of the Rio Aconcagua (33°S). In north-central Chile, the coastal range reaches 2000 m; between Valparaiso and Constitucion (35°S), it is low and cut with several river valleys. The coastal range is fairly continuous from Constitucion to Concepcion (37°S), where it becomes low and discontinuous (Miller 1976).

The mountains generally rise steeply from the water's edge, but in places they are set back from the shoreline in areas where stream valleys have widened into small, marshy coastal lowlands. A continuous coastal plain, however, does not exist.

A series of marine terraces occurs between 30 and 42°S, with well-preserved terraces occurring at 5–7, 35–40, and 100–300 m above sea level between 30 and 33°S. The terraces were formed during the mid- to late Quaternary, although their origin is uncertain (Fuenzalida *et al.* 1965).

Map 12.2 (Chile-2)
Distribution of Nearctic shorebirds along the Chiloe coast of Chile


75°
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72°
41°
42°
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CHILE
Purranque
Puerto Varas
Puerto Montt
Seno de Reloncaví
Punta Quillagua
Maullin
Chile - Concepcion Eco-unit
Chile - Chiloe Eco-unit
Ancud
Golfo de Ancud
Castro
Chonchi
Chiloe Island
Cabo Quilan
Chaiten
Golfo Corcovado
Rio Tic Toc
Boca del Guafo
Pacific Ocean
Archipielago de los Chonos
L M S
S M L
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
0 10 20 40 60 80 100 km
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Table 12.5
Totals of Nearctic shorebirds in survey sectors in Map 12.2 (Chile-2)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Surfbird	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
21	35.4	500	200	700	0	0	0	0	204	142	0	346	1 046
22	47.5	0	0	0	0	0	0	0	0	0	0	0	0
23	39.2	5	0	5	0	0	0	0	0	2	0	2	7
24	25.6	430	0	430	0	0	0	0	12	0	0	12	442
25	30.7	0	0	0	0	0	0	0	0	0	0	0	0
26	43.5	200	0	200	0	0	0	0	5	0	0	5	205
27	77.6	595	110	705	0	1	0	1	529	1 950	0	2 479	3 185
28	24.9	0	0	0	0	1	0	1	53	21	0	74	75
29	38.1	2 630	1 030	3 660	0	0	5	5	28	660	0	688	4 353
30	45.9	1 002	0	1 002	0	2	0	2	699	870	0	1 569	2 573
31	44.4	40	0	40	0	1	0	1	603	250	0	853	894
32	65.4	0	0	0	0	0	10	10	400	250	0	650	660
33	32.2	180	0	180	0	0	0	0	30	580	0	610	790
34	34.6	1 600	0	1 600	0	1	0	1	98	400	2	500	2 101
35	71.5	0	0	0	0	10	0	10	126	300	0	426	436
36	39.5	15	0	15	0	1	5	6	39	0	0	39	60
37	61.4	50	0	50	0	0	7	7	226	1 650	0	1 876	1 933
38	47.5	0	0	0	0	0	0	0	0	0	0	0	0
39	30.4	0	0	0	0	0	0	0	0	0	0	0	0
40	24.8	80	50	130	0	0	0	0	0	0	2	2	132
41	46.1	0	105	105	0	0	0	0	0	0	0	0	105
42	44.9	36	30	66	0	0	0	0	4	0	0	4	70
43	36.7	533	325	858	10	2	56	68	371	55	0	426	1 352
44	27.4	0	0	0	0	0	0	0	23	0	0	23	23
45	18.4	57	10	67	10	0	10	20	60	0	0	60	147
46	19.2	0	0	0	0	0	0	0	2	0	0	2	2
47	28.8	0	0	0	0	0	0	0	0	0	0	0	0
48	23.2	193	10	203	0	0	102	102	265	0	0	265	570
49	30.1	0	0	0	0	0	0	0	162	0	0	162	162
50	34.0	0	0	0	0	0	0	0	0	0	0	0	0
51	40.1	110	0	110	0	12	110	122	344	2 080	0	2 424	2 656
52	37.9	0	0	0	0	0	0	0	65	0	0	65	65
53	72.5	64	150	214	0	0	0	0	1 100	2 860	0	3 960	4 174
54	33.3	870	4 700	5 570	0	0	0	0	27	0	0	27	5 597
55	79.3	1 004	2 250	3 254	0	133	300	433	735	572	0	1 307	4 994
56	41.5	120	0	120	0	0	0	0	1	0	0	1	121
57	18.1	0	0	0	0	0	0	0	0	0	0	0	0
58	21.2	0	0	0	0	0	0	0	0	0	0	0	0
59	20.1	0	0	0	0	0	0	0	0	0	0	0	0
Total	1 532.9	10 314	8 970	19 284	20	164	605	789	6 211	12 642	4	18 857	38 930

Table 12.6
Principal habitats in survey sectors in Map 12.2 (Chile-2)

Sector no.	Habitat description
21	Broad sandy beaches, estuarine inlet with mudflats / some headlands and cliffs / low rolling forested hills
22	Narrow sand and gravel beach / eroding, partly vegetated cliff / thick forest
23	Sand and gravel beaches / steep headlands / forest
24	Gravel and long sand beaches / steep rocky headlands / forest
25	Rocky, steep mountainside / forest
26	Sandy beaches and sheer headlands, sandy estuary / rocky, steep mountainside; forest
27	Sand beaches, rocky headlands / forests
28	Inland; estuarine mudflat with marsh, wet grasslands / fields
29	Sand and gravel beaches, rocky cliffs and headlands, bay with sandy flats / agricultural fields
30	Bays with marshy deltas and gravel beach / some cliffs / open fields
31	Gravel beach / some cliffs / hills with forest and fields
32	Gravel beach / some cliffs / hills with forest and fields
33	Gravelly sandflats, gravel beach / hills with forests and fields
34	Estuarine salt marsh, sand beaches / forested hill
35	Estuarine mudflats, salt marsh, gravel beach / forested hills
36	Estuarine mudflats, salt marsh, gravel beach / forested hills
37	Estuarine mudflats, gravel beach / forested hills
38	Rocky shore / forest
39	Broad sand beaches with rocky headlands / forest
40	Sand beach, rocky points / few cliffs / forested mountains
41	Sand beach, rocky foreshore / forested mountains
42	Sandy delta, sand and rocky beaches / forested mountains
43	Rocky and sand beaches, lagoon in sandy delta / forest
44	Steep gravel beach / farms, forested mountains
45	Gravel and rocky beach / farms, forested hills
46	Gravel and rocky beach / farms, forested lowlands and hills
47	Gravel and rocky shore / steep forested mountains
48	Sand and gravel beaches / lowland forest
49	Rocky beaches / hills, forests, farms
50	Steep rocky fjord / forested hills
51	Estuarine delta; mud- and sandflats, rocky beach / forested hills
52	Rock and gravel beach and points / forested hills with farmland
53	Bays with rocky deltas, gravel beaches / some cliffs / forested hills with farmland
54	Sand and gravel beaches, estuarine inlets with marsh / cliffs / fields
55	Sand and gravel beach, estuary with mudflat and salt marsh / grassland
56	Rocky shore, some sand and gravel beaches / vegetated cliffs / forest
57	Rocky shore, some sand and gravel beaches / vegetated cliffs / forest
58	Rocky shore, some sand and gravel beaches / vegetated cliffs / forest
59	Rocky shore, some sand and gravel beaches / vegetated cliffs / forest

The highest terrace, thought to be of marine origin, lies along the base of the mountain slope and is partly covered by alluvial fans. The middle terrace is separated by an escarpment from the highest terrace, although it shows evidence of being covered by the sea and is of mid-Quaternary age. The lowest terrace is bordered by a sea cliff and is of late Quaternary age. The lower terrace may be the result of glacioeustatic changes in sea level, whereas the upper terraces may have been produced by tectonic events, such as continental uplift or the opening of new oceanic trenches (Fuenzalida *et al.* 1965).

Between 30 and 32°S, the rocky coastline is relatively straight, cliff faces alternating with pocket beaches. South of 32°S, the coastline becomes more indented. Transverse and parabolic dunes are present. From 33 to 36°S, the coastline varies between cliffs, bluffs, and sandy bays (Araya-Vergara 1985).

An estuarine delta has formed at the mouth of the Rio Itata, and accretional beach ridges and dunes have developed north of the mouth of the Rio Maule at Constitucion.

In central Chile, the higher rainfall has produced greater runoff and larger yields of fluvial sediments. In recent years, this sedimentation has increased because of deforestation (Bird 1985). In the last century, it has been estimated that 24% of the coastline in La Zona Central has advanced, 25% has retreated, and the other 50% has not changed (Araya-Vergara 1985). At Quintero (33°S), sand deposition over the last century has resulted in an island becoming attached to the mainland, and at Chanaral the beach has prograded 250 m as a result of fluvial sediment deposition (Paskoff, in Bird 1985). Sandy coastlines have prograded at San Antonio, Trinchera-Quivalgo, and Vina del Mar (Araya-Vergara 1985).

A broad delta is found at the mouth of Chile's largest river, the Rio Bio-Bio (36°45′S) (Sergerstrom 1964). Active dunes occur near the mouth of the Rio Bio-Bio and at the coast south of the Rio Mataquito (Psuty and Mizobe 1982). Soft cliffs appear along the coastline of the Arauco Peninsula and have supplied eroded sediment to the beach ridges in the Bahia de Arauco. The dunes south of the Arauco Peninsula are supplied with sediment from cliff erosion and river deposition and are the most extensive on the Chilean coastline.

In the vicinity of Concepcion (36°S), the coastline is low and covered with sand dunes between Rio Andalien and Talcahuano. An alluvial plain runs between Concepcion and Talcahuano, limited to the south by the Rio Bio-Bio and to the west by the Pacific Ocean and the peninsulas of Tumbes and Tetas. These peninsulas have steep irregular seaward coasts and are covered in hills rising to 250 m (Galli and Sanchez 1963). The Rio Andalien runs west to Concepcion, where it is deflected north towards the wide estuary at Penco. Puerto Saavedra (39°S) is sheltered from the open ocean by a long sand spit off the coast. A 1.5-km-wide channel carries water from the Rio Imperial, the main river of the area, to the sea. The coastline is smooth between 37 and 39°S. At Valdivia, a small fluvial plain has accumulated at the mouth of the river, and an estuary has formed. Between Queule and the west coast of Chiloe Island, the shores are rocky with cliffs cut into local outcrops (Araya-Vergara 1985).

In the south of La Zona Central, between 40°S and 41°25′S, the geotectonic divisions of northern Chile still exist. The Coastal Cordillera is a low, rounded, tectonically active mountain range. It is unglaciated and consists mainly of Precambrian and Paleozoic metamorphic rocks. The Central Valley depression is less than 250 m in altitude and 90 km broad at the maximum and is drowned in the southern part where it becomes the Gulf of Ancud. To the east of the valley runs the Andean Cordillera.

12.4.2. Climate

In the southern part of La Zona Central (31–42°S), the climate changes abruptly in the vicinity of the Rio Bio-Bio from arid desert to the transition zone of central Chile. A nine-month dry season and an annual rainfall of 250 mm occur in the northern part, whereas in the area around Puerto Montt rainfall is approximately 2000 $mm \cdot yr^{-1}$ and there is no real dry season. The difference in precipitation is reflected in a change of vegetation, from the mediterranean scrub forest of the northern half of central Chile to the patches of evergreen trees along the coast of south-central Chile (Miller 1976). One reason for the abrupt change in climate is that the fragmented nature of the coastal mountains south of the Rio Bio-Bio reduces their efficiency as a barrier to precipitation and temperature. Rainfall is maximum along the coast, diminishing towards the interior, and increasing again at the Andes. Temperature differences between the coast and inland also decrease as the coastal barrier becomes smaller.

In the northern half of La Zona Central, heavy fog is common along unprotected coasts. Prevailing winds are southwesterly north of the Rio Bio-Bio; south of this area, the winds are southerly to southwesterly in the summer, changing to strong northwesterly in the winter.

12.4.3. Vegetation

The abrupt change of climate in the Rio Bio-Bio area is reflected in a change in vegetation, as the semiarid northern zone yields to a mediterranean climate. Evergreen trees and bushes make their appearance near the coast. South of 33°S, the vegetation becomes denser. In this region, the Central Valley and river valleys have the most fertile agricultural land in Chile. The vegetation zone in central Chile is known as the "Chilean mattoral"; it is similar to the chapparal of Baja California and includes species of both the coastal desert and the temperate forest. Characteristic plants include cacti, acacias, laurels, and beeches (Jones, in Psuty and Mizobe 1982).

12.4.4. Shorebird distribution

12.4.4.1. Concepcion eco-unit

Sectors 56–78; Maps 12.2 (Chile-2) to 12.4 (Chile-4)

Most of the coastline in the Concepcion eco-unit consisted of steep cliffs or ocean beach (Tables 12.6, 12.8, and 12.10), and the only Nearctic shorebird species occurring in any appreciable numbers were Sanderling and Whimbrel. The 4500 Sanderlings in the eco-unit represented 4.1% of the South American total for the species (15.0% of the Chilean total for the species), whereas the 620 Whimbrels represented 2.5% of the South American total (8.0% of the Chilean total) (Tables 12.2, 12.5, 12.7, and 12.9).

The outer coastline in the southern parts of the eco-unit, from Punta Quillagua to the Valdivia area (Sectors 56–66), consisted mostly of a steep shoreline of vegetated cliffs with wind-sculptured trees and a surf-washed rocky foreshore, interspersed with occasional sand or gravel beaches (Tables 12.6 and 12.8). This section thus

Chiloe area, southern Chile. Marshy deltas occurring at the heads of inlets on the coasts of Chiloe Island and around the Golfo de Ancud support substantial numbers of Hudsonian Godwits and Whimbrels.

contained practically no suitable habitat for shorebirds, and, apart from the 120 Sanderlings seen near Punta Quillagua on a beach before the cliff coast started, shorebird totals were very low: no Nearctic shorebirds were recorded on the cliff coastline north to the Rio Bueno (Sector 62), and only scattered Whimbrels and Sanderlings were seen north to Sector 66, north of the Valdivia estuary (outer-coast sector totals ranged from two to 12 shorebirds). Much of the shoreline in the Valdivia estuary itself (Sector 65) was steep; although there were a number of quite extensive marshy areas, few shorebirds were seen (25 Whimbrels; Table 12.7).

Much of Sector 67 was steep and cliffy, although beaches opened out towards the northern end, and most of the shorebirds seen were in the area of the river mouth at La Barra.

North of Punta Ronca, a series of long sandy beaches begins, running north through Sectors 68–70 (Table 12.8). Steep headlands in Sector 68 give way to lower rolling hills behind the shore in Sectors 69 and 70. Lago Budi and the mouth of the Rio Imperial are found in Sector 70. Shorebird totals picked up considerably along these sandy beaches, particularly in Sector 69 between the Rio Tolten and southern end of Lago Budi. Sanderlings were observed scattered along the beach as territorial individuals as well as in flocks and were the most common shorebird, with totals of 230, 580, and 170 birds in Sectors 68, 69, and 70, respectively. Whimbrels were also encountered regularly, with totals of eight, 170, and 19 in the same respective sectors (Table 12.7). The only other Nearctic shorebirds observed in these sectors were 25 yellowlegs in the marshes at the north end of Lago Budi in Sector 70; these marshes were surrounded with long grass and appeared to be freshwater.

Steeper, rockier shoreline returned in Sector 71 between Punta Manuel and Punta Tirua, and shorebird totals were again low; only 11 Whimbrels were found on sand and gravel beaches along the coast.

North of Punta Nena (Sector 72), the coast again opens out, with long ocean beaches backed by a wide sandy grassland running north to Punta Morguilla (Sector 73). A section of rocky coast occurs around Punta Morguilla, before further beaches are found south of Morro Carnero at the north end of Sector 74. Sanderlings were numerous along these beaches, particularly in Sector 73 (1500), and Whimbrels occurred in smaller numbers throughout the area.

The outer coast of the Arauco Peninsula, forming Sector 75, was steep and cliffy (Table 12.10), with only 10 Whimbrels found on the occasional sandy beaches occurring between headlands.

Most of the Nearctic shorebirds found along the southern side of Bahia de Arauco in Sector 76 occurred near the river mouths west of and at Arauco and consisted of Sanderlings (610) and Whimbrels (200) (Table 12.9). Large numbers of gulls occurred in the river mouth at Arauco. Most of the Sanderlings seen in Sector 77 were on the dark sand beaches running northwards between Coronel and the estuary at Concepcion; the latter contained enormous areas of sandbars on which large numbers of gulls were roosting, but no Nearctic shorebirds were found.

The peninsula northwest of Concepcion could not be surveyed, but is unlikely to have supported many shorebirds; only one Whimbrel was observed on the dark sand

Map 12.3 (Chile-3)
Distribution of Nearctic shorebirds along the Valdivia coast of Chile

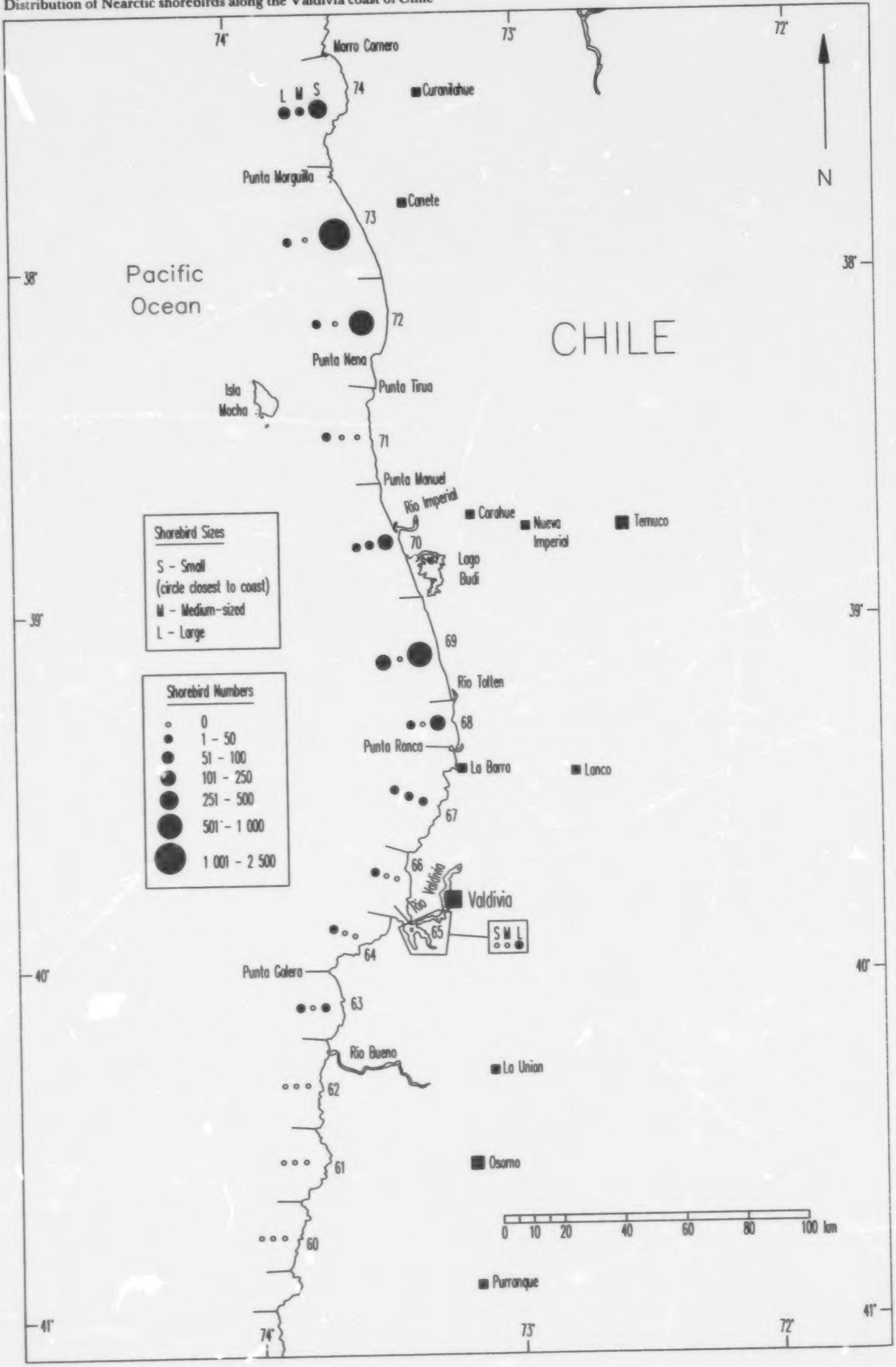
74°
73°
72°
38°
39°
40°
41°
N
Morro Carnero
L M S
74
Curanilahue
Punta Morguilla
Canete
73
Pacific Ocean
72
CHILE
Punta Nena
Punta Tirua
Isla Mocha
71
Punta Manuel
Rio Imperial
Carahue
Nueva Imperial
Temuco
70
Lago Budi
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
69
Rio Tolten
68
Punta Ronca
La Barra
Lanco
67
66
Rio Valdivia
Valdivia
65
S M L
64
Punta Galera
63
Rio Bueno
La Union
62
Osorno
61
0 10 20 40 60 80 100 km
60
Purranque

Table 12.7
Totals of Nearctic shorebirds in survey sectors in Map 12.3 (Chile-3)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
60	30.4	0	0	0	0	0	0	0	0	0
61	35.1	0	0	0	0	0	0	0	0	0
62	35.6	0	0	0	0	0	0	0	0	0
63	28.3	1	0	1	0	0	0	11	11	12
64	31.7	0	0	0	0	0	0	4	4	4
65	49.8	0	0	0	0	0	0	25	25	25
66	22.4	0	0	0	0	0	0	2	2	2
67	50.4	0	20	20	11	0	11	42	42	73
68	25.9	232	0	232	0	0	0	8	8	240
69	41.3	584	0	584	0	0	0	172	172	756
70	41.8	168	0	168	25	0	25	19	19	212
71	32.1	0	0	0	0	0	0	11	11	11
72	83.1	559	0	559	0	0	0	32	32	591
73	83.1	1 464	0	1 464	0	0	0	23	23	1 487
74	44.5	420	0	420	0	15	15	54	54	489
Total	635.5	3 428	20	3 448	36	15	51	403	403	3 902

Table 12.8
Principal habitats in survey sectors in Map 12.3 (Chile-3)

Sector no.	Habitat description
60	Rocky shore, some sand and gravel beaches / vegetated cliffs / forest
61	Rocky shore, some sand beaches / forested hills
62	Rocky shore, some sand beaches / forested hills
63	Sand beach, rocky shore / forested hills
64	Sand and gravel beaches, rocky shores / partly forested hills
65	Rocky outer shore, marshy inlet / forested hills
66	Sand beaches with rocky points / scrubby forest, farmland
67	Sand beaches with rocky points and cliffs / river valley, forest
68	Broad sand beach, steep headlands / dunes
69	Sand beach / grassy hillsides
70	Sand and gravel beaches / hills, farmland, lake and river
71	Rocky shoreline, some sand and gravel beaches / some cliffs / scrubby hills
72	Sand beach / flat sandy grassland with occasional rocky hills
73	Sand beach / flat sandy grassland
74	Sand beach with rocky sections / dunes / sandy grassland, hills

beaches and bouldery shoreline between Concepcion and Tome (Sector 78).

12.4.4.2. Valparaiso eco-unit

Sectors 79–97; Maps 12.4 (Chile-4) and 12.5 (Chile-5)

The Valparaiso eco-unit, stretching from just north of Concepcion to just north of the Rio Aconcagua near Valparaiso (Sectors 79–97), contained the highest number of Nearctic shorebirds (9600) recorded on the Pacific coast of Chile north of the Chiloe area. The majority (87.6%) of these birds were Sanderlings, the eco-unit total of 8400 representing 7.6% of the South American total for the species and 27.9% of the Chilean total. Whimbrels were the next most common species (380; Tables 12.9 and 12.11).

Sandy ocean beaches were particularly well developed in this eco-unit and were present to some extent in most sectors, a factor probably accounting for the high eco-unit total of Sanderlings, considering the length of coastline surveyed was the shortest of the Chilean eco-units.

In the south of the eco-unit, rocky headlands and points persisted through Sectors 79–81, although mixed with sandy bays and beaches, backed in some sections by a flat, sandy coastal plain (Table 12.10). No Nearctic shorebirds were found on the sandflats exposed in the mouth of the Rio Itata (Sectors 79 and 80), although large flocks of roosting gulls were present. Totals of Sanderlings were moderate to high in all coastal sectors north to Punta Topocalma, varying from 250 (Sector 79) to 2900 (Sector 85). Sanderlings were common along the beaches north of the Rio Itata (Sector 80), the shoreline being backed with sandy areas and fields leading to hills. Sanderlings were also common along the northern half of the Bahia de Chanco (Sector 82), where the beach was backed by dunes and a sandy hinterland. Grey sand beaches continued north through Sectors 83 and 84, becoming gravel on the long stretch of shoreline backed by a sandy wasteland north of Constitucion in Sector 84. Small numbers of peeps were found in ponds behind the gravel beach in this section of coast. Sand beaches, backed by a large sandy hinterland leading to barren hills, returned in the southern part of Sector 85 running north to the Rio Mataquito, and Sanderling numbers reached their peak along the coast on this section and on the somewhat rockier shoreline north of Iloca. Sections of beach backed by low, scrubby hills, interspersed with rocky slabs and points, continued to the north of Pichilemu (Sector 90), before a rocky coastline began to the south of Punta Topocalma. Sanderlings were common on the beaches both south and north of Pichilemu. The 280 peeps in Sector 85 were observed on flats in the mouth of the Rio Mataquito. No shorebirds were found on the freshwater habitats at Laguna Vichuquen (Sector 87); small numbers occurred on a series of salt pans and wet fields just to the north (Sector 88), including three yellowlegs and 15 Whimbrels (Table 12.9).

North of Punta Topocalma, the coast in Sector 91 became steeper and rockier, with some sections of sandy beach on which small numbers of Sanderlings (25) and Whimbrels (38) were observed. North of Matanzas, sand and gravel beaches became more common again. Beaches were quite narrow in Sector 92 and numbers of Sanderlings moderate (140), whereas numbers increased on the beaches and dunes north and south of San Antonio in Sectors 93 (520) and 94 (520) (Table 12.11). Progradation of the sandy coastline by some 600 m has occurred at San Antonio during the last century (Araya-Vergara 1985), and accretion has occurred alongside breakwaters in the

Map 12.4 (Chile-4)
Distribution of Nearctic shorebirds along the Concepcion coast of Chile

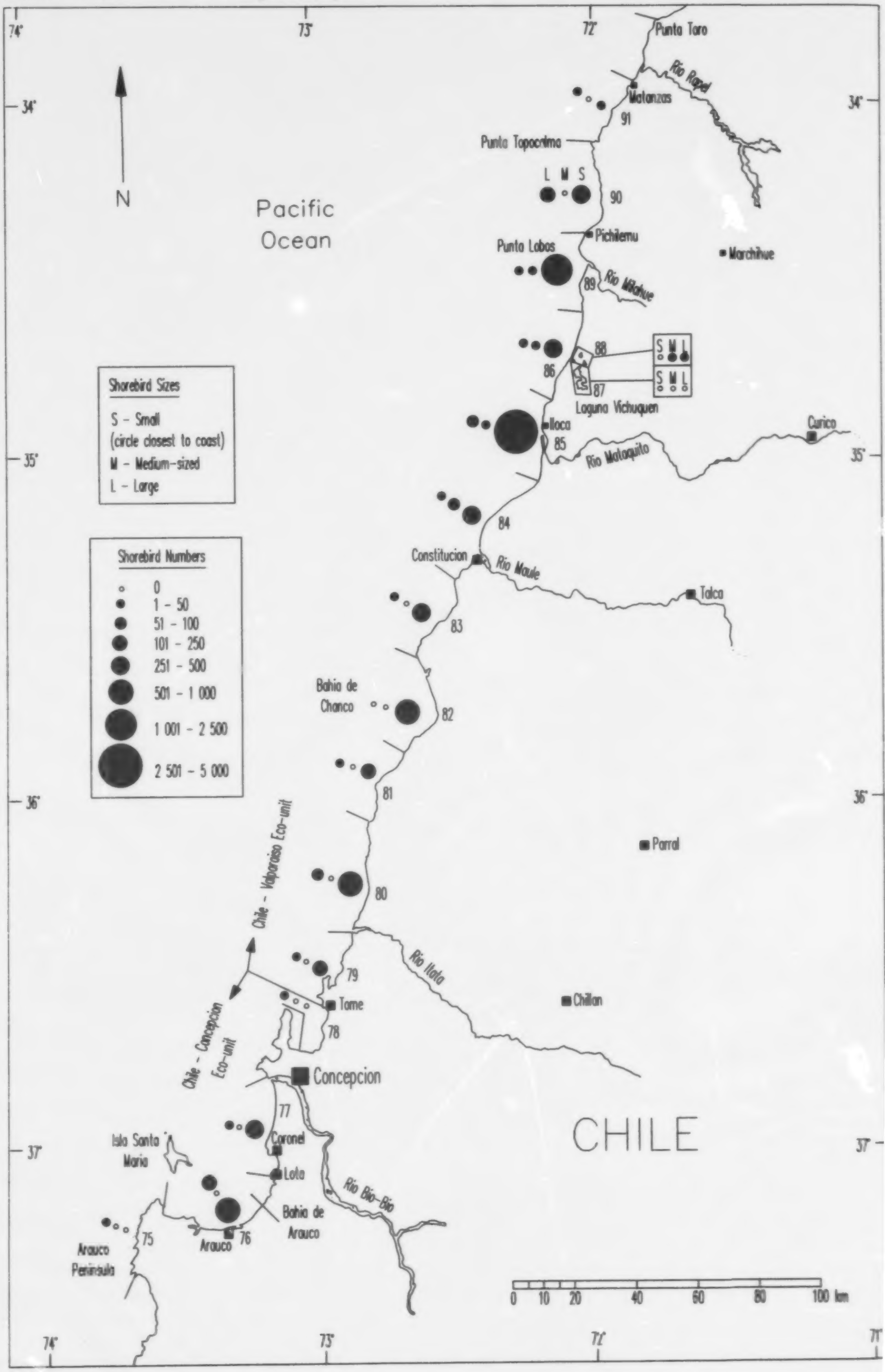
74°
73°
72°
71°
34°
35°
36°
37°
N
Pacific Ocean
CHILE
Punta Toro
Río Rapel
Matanzas
91
Punta Topocalma
L M S
90
Pichilemu
Marchihue
Punta Lobos
89
Río Nilahue
88
86
87
S M L
S M L
Laguna Vichuquen
Iloca
85
Río Mataquito
Curico
84
Constitucion
Río Maule
Talca
83
Bahia de Chanco
82
81
Parral
80
Chile - Valparaiso Eco-unit
Río Itata
79
Tome
78
Chillan
Chile - Concepcion Eco-unit
Concepcion
77
Coronel
Isla Santa Maria
Lota
Río Bío-Bío
Bahia de Arauco
Arauco
76
75
Arauco Peninsula
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
0 10 20 40 60 80 100 km

Table 12.9
Totals of Nearctic shorebirds in survey sectors in Map 12.4 (Chile-4)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Surfbird	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
75	36.2	0	0	0	0	0	0	0	0	10	10	10
76	51.4	610	0	610	0	0	0	0	0	201	201	811
77	36.4	385	0	385	0	0	0	0	0	1	1	386
78	20.3	0	0	0	0	0	0	0	0	1	1	1
79	35.2	250	0	250	0	0	0	0	0	5	5	255
80	42.3	671	0	671	0	0	0	0	0	60	60	731
81	28.2	200	0	200	0	0	0	0	0	29	29	229
82	40.8	519	0	519	0	0	0	0	0	0	0	519
83	25.6	287	0	287	0	0	0	0	0	17	17	304
84	43.1	253	154	407	0	0	0	55	55	6	6	468
85	31.6	2 855	285	3 140	2	0	3	0	5	55	55	3 200
86	28.3	327	0	327	0	20	0	0	20	2	2	349
87	0.0	0	0	0	0	0	0	0	0	0	0	0
88	0.0	0	0	0	0	0	4	0	4	15	15	19
89	29.4	1 387	285	1 672	0	0	3	0	3	37	37	1 712
90	30.8	448	0	448	0	0	0	0	0	102	102	550
91	24.6	25	0	25	0	0	0	0	0	38	38	63
Total	504.2	8 217	724	8 941	2	20	10	55	87	579	579	9 607

Table 12.10
Principal habitats in survey sectors in Map 12.4 (Chile-4)

Sector no.	Habitat description
75	Cliffs, some sand beaches / scrub
76	Rocky beach, river mouth with muddy delta and marsh / scrubby hills, marsh
77	Sand beach, estuary with sandbars / grassland, pine plantations
78	Sand beaches, some bouldery shoreline / some cliffs / hills with scattered trees
79	Bays with sand beaches, rocky headlands / hills with scrub and some trees
80	Sand beaches, rocky headlands / sandy grassland rising to partly treed hills, scattered trees
81	Sand beaches with rocky points / sandy hills
82	Sand beach / dunes / sandy scrubland
83	Sand beaches / scrubby hills
84	Sand and gravel beaches / dunes / extensive sandy wasteland with some ponds
85	Sand beaches, lagoons and river exit / sandy hinterland, hills
86	Rocky beaches and headlands / scrubby hills with scattered trees
87	Inland; freshwater lake / scrubby hills with scattered trees
88	Inland; salt pans, wet fields / scrubby hills with scattered trees
89	Sand beaches with rocky outcrops / scrubby hills
90	Rocky points, small sand beaches / low scrubby hills
91	Rocky and sand beaches, river exits / steep rocky slopes with scrub, vegetated dunes

harbour (Pomar 1962). No Nearctic shorebirds were seen during a brief survey of the wetlands adjacent to the coast north of Punta Toro (Sector 93).

The sandy coastline gave way to a rockier shore towards the north of Sector 95 (Table 12.12), and no shorebirds were seen along the rocky shores and cliffs past Punta Curaumilla in Sector 96. Much of the shoreline around Valparaiso was steep or heavily urbanized; only 16 Whimbrels were observed on the beaches north of Concon and the mouth of the Rio Aconcagua to the end of Sector 97 north of Quintero.

12.5. Northern Chile

12.5.1. Geography and geomorphology

The desert coast of northern Chile extends southwards from the Peruvian border (18°S) to approximately 30°S near Coquimbo. This area includes the Atacama Desert between 22 and 27°S (McGinnies *et al.* 1968) and the semiarid zone between 27 and 30°S. The coast is very straight and runs almost north–south, lying between 70 and 71°W between Arica and Caldera. The coastline is dominated by the Coastal Cordillera, which rises sharply from sea level to 3000–5000 m. The coastal desert is a narrow strip bounded to the east by the Andes, within which varied landforms, geological formations, and rock types occur.

Offshore, the continental shelf is narrow and the continental slope is steep. The Atacama Trench, which has a depth of nearly 8000 m, lies offshore along El Norte Grande and El Norte Chico, resulting in a difference of some 14 000 m between the bottom of the trench and the highest peaks of the High Cordillera. Towards the south, the trench gradually becomes shallower and dies out.

Much of the coast consists of long lines of steep cliffs, broken now and then by a river channel. Small marine terraces are found along the foot of the cliffs near the coast, becoming more frequent and somewhat wider towards the south. The terraces were formed by the abrasion of the sea and were raised during uplift in the Quaternary period. The chronological order of these movements is clear, but they have not been accurately dated (Fuenzalida *et al.* 1965).

In northern Chile, terraces are found on the Peninsula of Mejillones and between Rio Loa and Iquique. From 27°S to 27°45′S, the marine terraces and elevated beaches south and southeast of Caldera consist principally of gravel deposited during the Pleistocene. From 28 to 30°S, the coast of the South Atacama Desert shows three phases of sea-level movements. Remnants of raised beaches indicate that during the first period of landform evolution, the sea level decreased at least 500 m below its present height. During the second phase, the sea transgressed to

Map 12.5 (Chile-5)
Distribution of Nearctic shorebirds along the Valparaiso coast of Chile

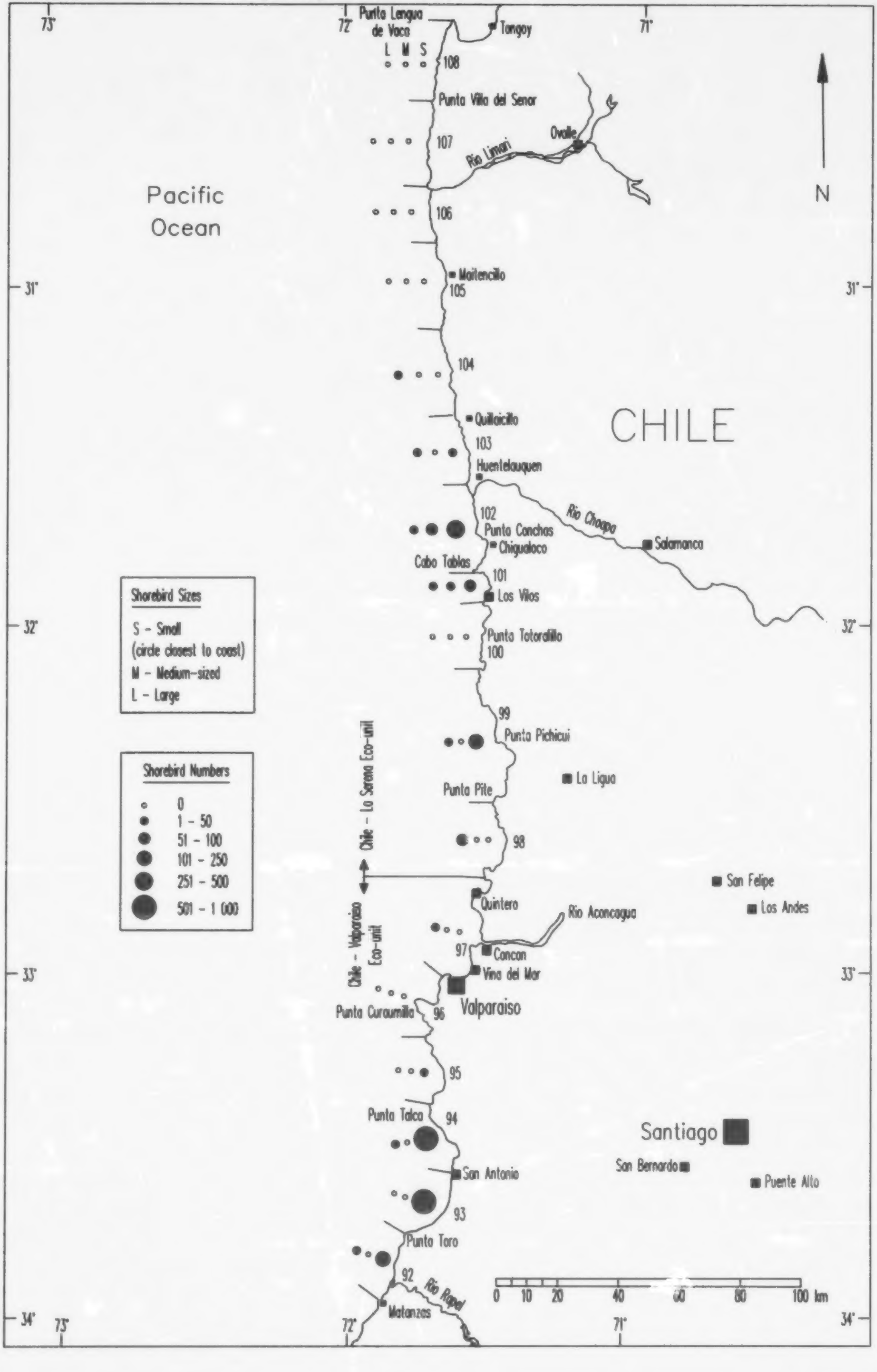
73°
72°
71°
31°
32°
33°
34°
Punta Lengua de Vaca
Tongoy
L M S
108
Punta Villa del Senor
107
Ovalle
Rio Limari
Pacific Ocean
N
106
Maitencillo
105
104
Quilaicillo
CHILE
103
Huentelauquen
102
Rio Choapa
Punta Conchas
Chigualoco
Salamanca
Cabo Tablas
101
Los Vilos
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Punta Totoralillo
100
99
Punta Pichicui
Chile - La Serena Eco-unit
La Ligua
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
Punta Pite
98
San Felipe
Quintero
Rio Aconcagua
Los Andes
Chile - Valparaiso Eco-unit
97
Concon
Vina del Mar
Valparaiso
Punta Curaumilla
96
95
Punta Talca
94
Santiago
San Antonio
San Bernardo
Puente Alto
93
Punta Toro
92
Rio Rapel
Matanzas
0 10 20 40 60 80 100 km

Table 12.11
Totals of Nearctic shorebirds in survey sectors in Map 12.5 (Chile-5)

Sector no.	Sector length (km)	Sanderling	Total small shorebirds	Surfbird	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
92	23.8	145	145	0	0	1	1	146
93	26.4	516	516	0	0	0	0	516
94	29.5	520	520	0	0	1	1	521
95	27.6	39	39	0	0	0	0	39
96	32.6	0	0	0	0	0	0	0
97	43.2	0	0	0	0	16	16	16
98	31.6	0	0	0	0	77	77	77
99	54.4	169	169	0	0	9	9	178
100	28.7	0	0	0	0	0	0	0
101	13.4	62	62	5	5	6	6	73
102	32.6	300	300	54	54	17	17	371
103	23.9	2	2	0	0	3	3	5
104	29.8	0	0	0	0	1	1	1
105	31.8	0	0	0	0	0	0	0
106	19.6	0	0	0	0	0	0	0
107	27.8	0	0	0	0	0	0	0
108	28.5	0	0	0	0	0	0	0
Total	505.2	1 753	1 753	59	59	131	131	1 943

Table 12.12
Principal habitats in survey sectors in Map 12.5 (Chile-5)

Sector no.	Habitat description
92	Sand, gravel and rocky beaches, sandy marsh at river exit, sheer cliff / scrub
93	Sand and gravel beach, marshland / scrub
94	Sand beach, rocky sections / scrubby forest
95	Sand beaches with rocky points / cliffs / scrubby hillsides
96	Rocky shoreline / cliffs / scrub
97	Sand beach with low rocky sections / vegetated dunes, sandy desert, low scrubby hills
98	Rocky shoreline with some sand beach / cliffs / scrubby hills
99	Rocky shore with some beaches / scrubland, hills
100	Rocky shore / rolling hills with grass and scrub, mountains
101	Sand beach, rocky points and shoreline / low scrub
102	Rocky shore / some cliffs / gently rising rocky scrub
103	Low rocky coast, small sand beaches / low sandy desert scrub, hills
104	Cliffs, rocks / scrub plateau
105	Cliffs / scrub plateau
106	Rocky shore / scrubby hills
107	Rocky shore / scrubby hills
108	Rocky shore / scrubby hills

110 m above present sea level, as indicated by the formation of an abrasion platform. Marine sand and gravel were deposited along the coast. During the third phase, the sea fell to its present level, leaving shorelines, abrasion platforms, and fossiliferous deposits.

Few rivers run in northern Chile because of the extreme aridity of the country. The rivers originate in the Andes, but many disappear in the desert and never reach the sea. Natural vegetation occurs only along riverbeds and where heavy sea fogs provide some moisture to the coastal hills; the rest of the coastline consists of a sparse desert environment. Agriculture is concentrated in the river floodplains on the bottom of the deep canyons that cut east–west across the landscape.

The Rio Loa is one of the few rivers in this region to have a relatively constant flow of water, reaching the Pacific throughout the year (Hollingsworth 1964). Its basin is floored by calcareous beds and associated detrital sediments, known as the Loa Formation. The course of the Rio Loa is determined in part by late crustal movements. Hollingsworth (1964) described an old valley of the Loa, floored by the Loa Formation, which is now perched 400 m above the Pacific at its seaward end; he suggested that the Loa Formation is probably pre-Pliocene.

South of the Rio Loa, no major water courses cross the Coastal Cordillera until the Rio Salado at Chanaral. Continuing south, the dissection of the coast increases, and the cliff is only partially preserved, but is still recognizable at Huasco (28°30′S) (Mortimer 1972). In 1973, a torrential runoff produced a flow of sediments from the Rio Arica near the Peruvian border, forming a delta (Bird 1985).

At 27°S, the Rio Copiapo flows into the Pacific. It is the only stream in the region, and much of its water is drawn off for irrigation purposes, thus reducing the discharge at its mouth to 200 $L \cdot s^{-1}$ (Sergerstrom 1965). Several broad marine terraces, dating from Pleistocene times, occur along the coast. The major terrace, known as the Llano de Caldera, extends 60 km along the coast, from Caldera to Bahia Salado, rising to 95–130 m above sea level. Three higher terraces remain at 150, 205, and 235 m above sea level (Sergerstrom 1963). South of Caldera, an escarpment marks the boundary between the Llano de Caldera terrace and a lower zone of terraces approximately 15–60 m above sea level (Sergerstrom 1964).

A number of marine abrasion terraces occurs at the mouth of the Huasco valley. Such terraces are better developed in the sheltered coastal environments near Coquimbo and La Serena and at the mouth of the Elqui Valley (30°S), 200 km south of the Huasco (Hollingsworth 1964).

The mining region of Domeyko lies between the Huasco and Elqui rivers. The area is dissected by a network of dry valleys, which converge on the Quebrada Chanaral, at the seaward end of which is found a series of raised beaches. At about 30°S, starting in the Rio Elqui valley, rainfall increases, and the desert begins to yield to a persistent grass cover.

Sand dunes are common along the coast in a wide variety of forms, from single crescent-shaped dunes to more complex ridges. Broad sandy alluvial fans are found at the mouths of streams (McGinnies *et al.* 1968).

12.5.2. Climate

The coastal regions of northern Chile belong to the oceanic type of desert (Petrov 1976). Despite the proximity of the sea, however, atmospheric precipitation is very meagre. The Rio Copiapo (27°S) marks the southern limit of the arid Atacama Desert, which dominates the north of Chile. South to 31°S, a semiarid zone occurs in which there is enough precipitation to allow some vegetation to grow. Conditions that produce the Atacama coastal desert include: (1) counterclockwise air currents along the coastline, approximately parallel to the prevailing flow of air around the oceanic high; (2) the northward flow of cold water in the Peru (Humboldt) Current; and (3) the proximity of the Andean Cordillera, which shields the Pacific shores from air from the east (Rumney 1968).

Marine air along the coast between 18 and 23°S is confined to the coastline by the sharp rise of the Coastal Cordillera and the lack of wide transverse valleys; it generally has a depth of about 1 km along the shore and penetrates inland through only a few narrow gorges. Weather conditions are uniform within this very narrow coastal band.

North of the Rio Copiapo (27°S), precipitation along the coast is very low (< 1 mm annually) (Miller 1976). The relative humidity north of 27°S is much lower than in the rest of Chile, and coastal fog is infrequent. Desert conditions continue between 27 and 31°S. Almost 90% of the rainfall occurs in the winter months (May–August), and there is enough to support some vegetation.

The air temperature of the coastal zone is cooler than inland (summer temperatures average 26°C inland compared with 18–19°C on the coast), because of the modifying effects of the sea.

12.5.3. Vegetation

Vegetation of the Chilean desert is very sparse. Its distribution in the low-lying areas at the base of the mountains is determined by fog, and higher up by atmospheric precipitation. Although northern Chile extends into the tropics, cool coastal currents and intense upwellings reduce the temperature of all coastal waters, and the area displays no tropical characteristics. There are no mangrove swamps, and salt marshes are scarce. West (1977) suggested that the lack of tidal marshes results primarily from the absence of sheltered bays and lagoons and the absence of river deltas with fine sediment, although their absence has also been attributed to the extreme aridity and cool air temperatures generated by the Peru (Humboldt) Current (Chapman 1975).

Most areas have sparse to nonexistent vegetation, but there are a few areas where plants can be found. Between 20 and 24°S, areas of seasonal vegetation known as *lomas* occur at altitudes of 300–1000 m, where the land has been exposed to sea fog. These fogs characteristically occur in winter, forming layers 300–400 m in height, enabling the soil to obtain the moisture that is needed for the development of plant life. The *loma* vegetation is predominantly made up of lower plants, including blue-green algae and lichens. As the fog increases and moisture accumulates in the surface horizons of the ground, other types of vegetation begin to appear, including perennial shrubs, grasses, cacti, succulents, and many ephemeral plants.

12.5.4. Shorebird distribution

12.5.4.1. La Serena eco-unit

Sectors 98–125; Maps 12.5 (Chile-5) and 12.6 (Chile-6)

The La Serena eco-unit, stretching from just north of the Rio Aconcagua to Caldera north of the Rio Copiapo (Sectors 97–125), contained moderate numbers of Nearctic shorebirds, the total of 4800 representing 3.8% of the Chilean total. The two most numerous species were Sanderling (4400; 4.5% of the Pacific Coast regional total, 3.9% of the South American total) and Whimbrel (290; 3.1% of the Pacific Coast total), both being the only species recorded in the small and large size categories, respectively. A small number (100), although an interesting variety, of medium-sized species was observed, including Lesser Golden-Plovers (14), Black-bellied Plovers (4), Ruddy Turnstones (29), and Surfbirds (61) (Tables 12.11 and 12.13).

The topography generally consisted of long sections of rocky or cliffy coastline, with some intervening sections of beach (Tables 12.12 and 12.14), the lack of suitable shorebird habitat thus accounting for the modest shorebird totals in the eco-unit and the predominance of Sanderlings and Whimbrels.

In the south of the eco-unit, Whimbrels (80) were the only Nearctic shorebirds observed on the beaches between the bay at Quintero and rocky areas leading to Punta Pite (Sector 98); these beaches appeared to be heavily used for recreation. Sanderlings (170) were quite common along the beaches in the middle part of Sector 99, particularly those south of Punta Pichicui, where marshy areas occurred around the river mouths, although people were also scattered along many of the beaches in this sector.

A predominantly rocky shoreline began in Sector 100, and the coastal topography changed to arid, open, rolling hills stretching to the mountains inland (Table 12.12). Small numbers of Sanderlings were seen on sandy beaches in the bay between Los Vilos and Cabo Tablas (60, Sector 101) and on sections of beach near Chigualoco and the Rio Choapa (300, Sector 102), where there was a small delta with flats. North of Huentelauquen to Punta Lengua de Vaca (Sectors 103–108), the coast was rocky, with some pocket beaches, alternating between cliffs and a low, rocky foreshore leading to arid, scrubby hills; this section was effectively devoid of Nearctic shorebirds.

The embayments at Bahia Tongoy (Sector 109), Bahia Guanaquero (Sector 110), and Bahia de Coquimbo (Sector 111) contain long sandy beaches (Table 12.14), which are important shorebird habitat. The wide bay system on this section of coast is well protected from the southwesterly ocean swell by a broad promontory of crystalline rock, and the present beaches are on swash alignments determined by refraction of the ocean swell (Araya-Vergara 1985). There were only a few Sanderlings on the long sand beach running along the south side of Bahia Tongoy (Sector 109); the beach is backed by a flat arid scrubland and has blocked off several river courses. Long sand beaches are found in the southern halves of Bahia Guanaquero (Sector 110) and Bahia de Coquimbo (Sector 111), especially north and south of the exit of the Rio Elqui at La Serena, and these stretches of beach supported some of the highest sector totals of Sanderling in Chile, despite fairly heavy use by humans. Bahia Guanaquero (Sector 110) contained 1800 Sanderlings and 23 Whimbrels, and there were 1300 Sanderlings and seven Whimbrels, as well as three Lesser Golden-Plovers, recorded in the Bahia de Coquimbo, mostly near the river exit at La Serena (Table 12.13).

Steep rocky shores returned in Sectors 112 and 113, with only occasional sand or gravel beaches, and few shorebirds were observed.

A long, yellow sandy beach, backed by wind-sculptured dunes and a vast sandy hinterland dotted with tufted vegetation, ran along the coast from the Quebrada de los Choros to the Isla Choros area. This beach supported most of the Sanderlings (290) in Sector 114, as well as small numbers of other species, including Lesser Golden-Plovers (7), Black-bellied Plovers (1), and Ruddy Turnstones (2); Whimbrels (53) also occurred along the beach and on the white sand beaches in the northern part of the sector (Table 12.13). The offshore islands were used by seabirds, although no Nearctic shorebirds were seen: Isla Choros rose steeply from the sea to a height of some 135 m, whereas the Isla Gaviotas and Isla Damas were low and rocky.

The enormous sandy hinterland continued through Sector 115, with a rocky foreshore alternating with sand and gravel beaches. Most of the Sanderlings (80) and Whimbrels (13) seen were on a sandy beach in the bay at the north end of the sector, whereas the turnstones (10) were in the southern, rockier part.

The coastline from Cabo Bascunan to the Rio Huasco (Sectors 116–118) was low and rocky, with some sand and gravel beaches, with the arid, sandy desert hillsides rising inland (Table 12.14). Few shorebirds were observed. A phenomenon noted near Huasco, and on many other parts of the coast, especially those with southwest-facing slopes, was an extensive blanket of sand covering the hillside. This covering of sand appeared to have been blown up the hill slopes by the prevailing southwesterly winds, in many cases right to the bases of the upper, steeply sloping ridges; a contrasting rocky belt ran along the shore in the zone washed by waves.

Most of the Sanderlings (80) in Sector 119 were found on sandy beaches north of the mouth of the Rio Huasco and in the northern part of the sector south of Punta Lobos. The green vegetation along the course of the Rio Huasco provided a contrast with the arid desert hill slopes dotted with tufts of vegetation and cactus. The central part of the sector was rockier, with small pockets of sand or gravel beaches.

The shoreline between Punta Lobos and Punta Cachos (Sectors 120–122) was generally low and rocky, with a series of ragged wave-washed points and rocky or gravel beaches backed by sandy, desert hill slopes, the relief becoming somewhat lower in Sector 122 (Table 12.14). No Nearctic shorebirds were seen in this area.

Sections of long, white sandy beaches in the southern parts of the embayments north of Punta Cachos (Sector 123), north of Punta Dallas near the mouth of the Rio Copiapo (Sector 124), and in Bahia Inglesa (Sector 125) supported modest totals of Sanderlings and Whimbrels, as well as small numbers of medium-sized species, including Lesser Golden-Plover, Black-bellied Plover, Ruddy Turnstone, and Surfbird (Table 12.13). The Rio Copiapo, near the southern limit of the Atacama Desert, is one of the northernmost rivers with a permanent runoff on the coast of Chile. A barrier built by longshore drifting has enclosed a lagoon behind the shoreline (Araya-Vergara 1985), producing a small area of wetland near the river exit, surrounded by sandy desert; beach ridges occur to the north of the river mouth. No Nearctic shorebirds were found in the lagoon ponds, and only small numbers of waterfowl (30 ducks, one egret, two flamingos). The remaining sections of coastline in Sectors 123–125 were low and rocky, with few or no shorebirds.

12.5.4.2. Antofagasta eco-unit

Sectors 126–145; Maps 12.6 (Chile-6) to 12.8 (Chile-8)

The Antofagasta eco-unit stretches from just north of Caldera (Sector 126) to the northern side of the Antofagasta Peninsula north of Mejillones (Sector 145). The coastline forms the seaward margin of the Atacama Desert. It is mostly rocky and wave-washed, often steep and precipitous, and exceptionally dry, so that few rivers, and hence little sediment, reach the coast (Tables 12.14, 12.16, and 12.18). Very few beaches are found, with the exception of the long stretches of sand on the south and north sides of the Antofagasta Peninsula, near Antofagasta and Mejillones, respectively. An enormous sandy wasteland forms the elongated isthmus of the peninsula, connecting the Cerro Moreno and hills along the outer coast of the peninsula with the mainland.

With little shorebird habitat available, totals for Nearctic shorebirds were generally very low, with the exception of substantial numbers of Sanderlings seen near Mejillones. The eco-unit overall total of 1500 shorebirds represented only 1.2% of the total for Chile and 0.7% of the shorebirds on the Pacific coast of South America (Tables 12.13, 12.15, and 12.17). Shorebird distribution was highly localized, with the bulk of the birds occurring on the beaches near Mejillones, which held 1200 (93%) of the 1300 Sanderlings in the eco-unit and 84% of the overall eco-unit total of 1500 shorebirds. Only 31 Whimbrels were seen in the eco-unit, spread along the coast in small numbers. The two Willets seen in the northern part of Sector 125 north of Mejillones were the most southerly observations of the species on either coast of the continent. The 130 medium-sized shorebirds included 110 Ruddy Turnstones and 15 Surfbirds, most of which (80 turnstones and all the Surfbirds) were found in the northern part of Sector 133 north of Taltal. This was the only area outside of the Antofagasta Peninsula that held any notable numbers of shorebirds; they were found on an isolated section of low, flat rocks interspersed with sand.

The remainder of the coast was mostly rocky, either low, wave-washed, and bouldery or steep and cliffed. Some sand and gravel beaches occurred in Sectors 126 and 127, and hillsides covered with a blanket of apparently wind-blown sand were a feature of the coast. The direction of the prevailing southwesterly winds was evident from the alignment of ridges and streaks of blown sand behind the shore in the area of Punta Obispo (Sector 126). One of the only areas of beach in the southern part of the eco-unit occurred north of Chanaral (Sector 128), where long stretches of white sand supported the few Sanderlings (6) seen outside the areas mentioned above. No outflow was noted from the Quebrada del Salado at Chanaral.

12.5.4.3. Arica eco-unit

Sectors 146–165; Maps 12.8 (Chile-8) and 12.9 (Chile-9)

The Arica eco-unit extended from north of Mejillones (Sector 146) to the border with Peru, north of Arica (Sector 165). The coastline was rocky and arid, forming the seaward margin of the Atacama Desert, and contained very few, restricted areas of habitat suitable for shorebirds. The overall eco-unit total (1500) was low, comprising 1.2% of the Chilean total (Tables 12.17 and 12.19). Sanderlings (1400) were the most numerous shorebird, making up the bulk of the eco-unit total (91.8%), followed by

Map 12.6 (Chile-6)
Distribution of Nearctic shorebirds along the La Serena coast of Chile

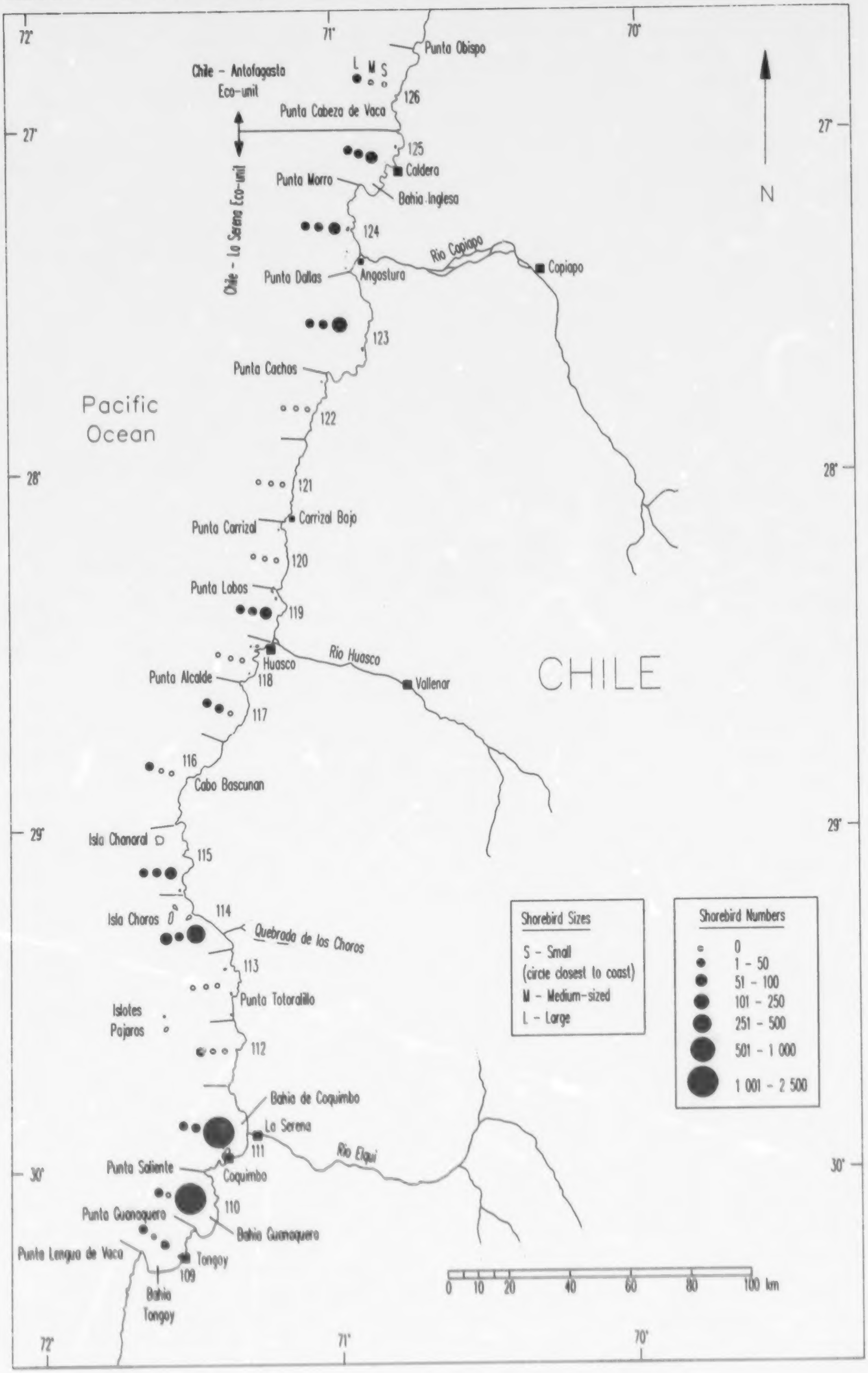
72°
71°
70°
27°
28°
29°
30°
N
Punta Obispo
Chile - Antofagasta Eco-unit
L M S
126
Punta Cabeza de Vaca
125
Caldera
Punta Morro
Bahia Inglesa
Chile - La Serena Eco-unit
124
Rio Copiapo
Copiapo
Punta Dallas
Angostura
123
Punta Cachos
Pacific Ocean
122
121
Punta Carrizal
Carrizal Bajo
120
Punta Lobos
119
Huasco
Rio Huasco
Vallenar
CHILE
Punta Alcalde
118
117
116
Cabo Bascunan
Isla Chanaral
115
Isla Choros
114
Quebrada de los Choros
113
Punta Totoralillo
Islotes Pajaros
112
Bahia de Coquimbo
La Serena
111
Rio Elqui
Punta Saliente
Coquimbo
110
Punta Guanaquero
Bahia Guanaquero
Punta Lengua de Vaca
Tongoy
109
Bahia Tongoy
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
0
10
20
40
60
80
100 km

Table 12.13
Totals of Nearctic shorebirds in survey sectors in Map 12.6 (Chile-6)

Sector no.	Sector length (km)	Sander-ling	Total small shorebirds	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Surfbird	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
109	33.5	13	13	0	0	0	0	0	1	1	14
110	31.0	1 750	1 750	0	0	0	0	0	23	23	1 773
111	46.7	1 334	1 334	3	0	0	0	3	7	7	1 344
112	25.3	0	0	0	0	0	0	0	10	10	10
113	27.2	0	0	0	0	0	0	0	0	0	0
114	28.0	287	287	7	1	2	0	10	53	53	350
115	31.2	76	76	0	0	10	0	10	13	13	99
116	33.9	0	0	0	0	0	0	0	1	1	1
117	23.6	0	0	0	0	0	1	1	6	6	7
118	20.6	0	0	0	0	0	0	0	0	0	0
119	20.8	83	83	3	0	0	0	3	13	13	99
120	24.3	0	0	0	0	0	0	0	0	0	0
121	32.2	0	0	0	0	0	0	0	0	0	0
122	24.6	0	0	0	0	0	0	0	0	0	0
123	50.7	113	113	1	0	6	0	7	10	10	130
124	32.6	99	99	0	3	10	1	14	30	30	143
125	37.9	90	90	0	0	1	0	1	3	3	94
126	35.1	0	0	0	0	0	0	0	4	4	4
Total	559.2	3 845	3 845	14	4	29	2	49	174	174	4 068

Table 12.14
Principal habitats in survey sectors in Map 12.6 (Chile-6)

Sector no.	Habitat description
109	Sand beach changing to rocky shore / rolling scrubby grassland
110	Sand beach changing to steep rocky shore / scrubby hillsides
111	Sand beach, river exit, rocky shore with boulders / rocky hills, towns, fields
112	Steep rocky shore with occasional sand beach / rocky scrubland
113	Steep rocky shore with occasional beach / rocky scrubland
114	Sand beach with rocky islands offshore / sandy desert
115	Rocky shoreline, some sand beach / vast sandy desert, mountains
116	Low rocky shore / vast sandy scrubland, mountains
117	Low rocky shore with sand beaches / steep sandy desert hillside, mountains
118	Rocky shore / sandy desert slopes, rocky hills, mountains
119	Low rocky shore, some sand beaches / sandy desert slopes, mountains
120	Low rocky shore with ragged points / sandy rock-strewn desert slopes, mountains
121	Low rocky shore with ragged points / sandy rock-strewn desert slopes, mountains
122	Low rocky shore with ragged points / sandy rock-strewn desert slopes, mountains
123	Sand beaches, some low rocky shore / flat sandy hinterland
124	Sand beaches, some rocky sections / cliffs / flat sand desert, marshy pools
125	Sand beaches, some low rocky points / rocky cactus desert
126	Low rocky foreshore / flat, gently sloping rock desert

Whimbrels (60): both species were the only ones recorded in their respective size categories. Small numbers of medium-sized species were recorded in the eco-unit, including a Lesser Golden-Plover (1), Black-bellied Plovers (22), Ruddy Turnstones (6), and Surfbirds (4), as well as 30 unidentified birds.

Shorebird distribution was highly clumped, with two coastal stretches supporting most of the birds. The first area involved the section of coast around the mouth of the Rio Loa (Sectors 152 and 153), which supported 690 birds, or 46.8% of the eco-unit total, and the beaches near Arica, which supported 680 birds, or 46.1% of the eco-unit total.

Most of the coastline in the southern part of the eco-unit between Punta Chacaya and Punta Arena (Sectors 146–151) was rocky and barren (Table 12.18). The sandy beaches north of the Antofagasta Peninsula gave out north of Punta Chacaya (Sector 146), being replaced by gravel or boulder beaches and a rocky coastline, some parts of which were jagged and rough and volcanic in appearance. Inland, desert hillsides rose to the mountains, with cactus starting about halfway up the slopes. Occasional abandoned or semiabandoned mines and towns were perched along the coastline, the nearby cemetery, with a jumble of iron crosses, lending a grim perspective to the steep, parched landscape. Pollution from yellow, sulphurous-looking waste seeped onto the shore near some of the mines, e.g., near Caleta Michilla. An occasional dried-up river course reached the shore. Very few Nearctic shorebirds were seen in this stretch.

Towards the northern part of Sector 151, south of Punta Arena, the coastline became somewhat lower in relief, with a flat rocky shoreline backed by gently rising desert slopes leading to the mountains inland (Table 12.18). Flat rocky slabs appeared along the shore, in many places forming a wet, wave-washed platform, which resembled a miniature version of the *restingas* occurring along the coast of Argentina. South of the Rio Loa, the beaches were mostly gravel or rocky; to the north, particularly in Sector 153, the beaches were sandy, becoming more gravelly again in Sector 154. Shorebirds appeared to be clearly associated with the mixture of "mini-*restingas*" and beaches along this section of coast, both to the north and to the south of the Rio Loa. Sanderlings were most numerous along the sandy beaches found in the bays and indentations in the coast north of the river mouth, with the somewhat rockier stretches south of the river supporting Sanderling and a variety of medium-sized species. With the return of the rocky coast from Sector 155 northwards, shorebird numbers fell dramatically again. Vast blankets of sand covered the southwest-facing hill slopes, from just behind the shoreline to the steep slopes below the upper ridges. This phenomenon, apparently the result of sand being blown inland by the prevailing southwesterly winds, was noted in Sectors 153–156.

The coast north of Iquique to Arica was mostly very steep and rocky (Table 12.20), and very few Nearctic shorebirds were recorded. The green of the vegetation along the valley of the Rio Camarones (Sector 162) provided a contrast with the stark desert coastline, and

Map 12.7 (Chile-7)
Distribution of Nearctic shorebirds along the Antofagasta coast of Chile

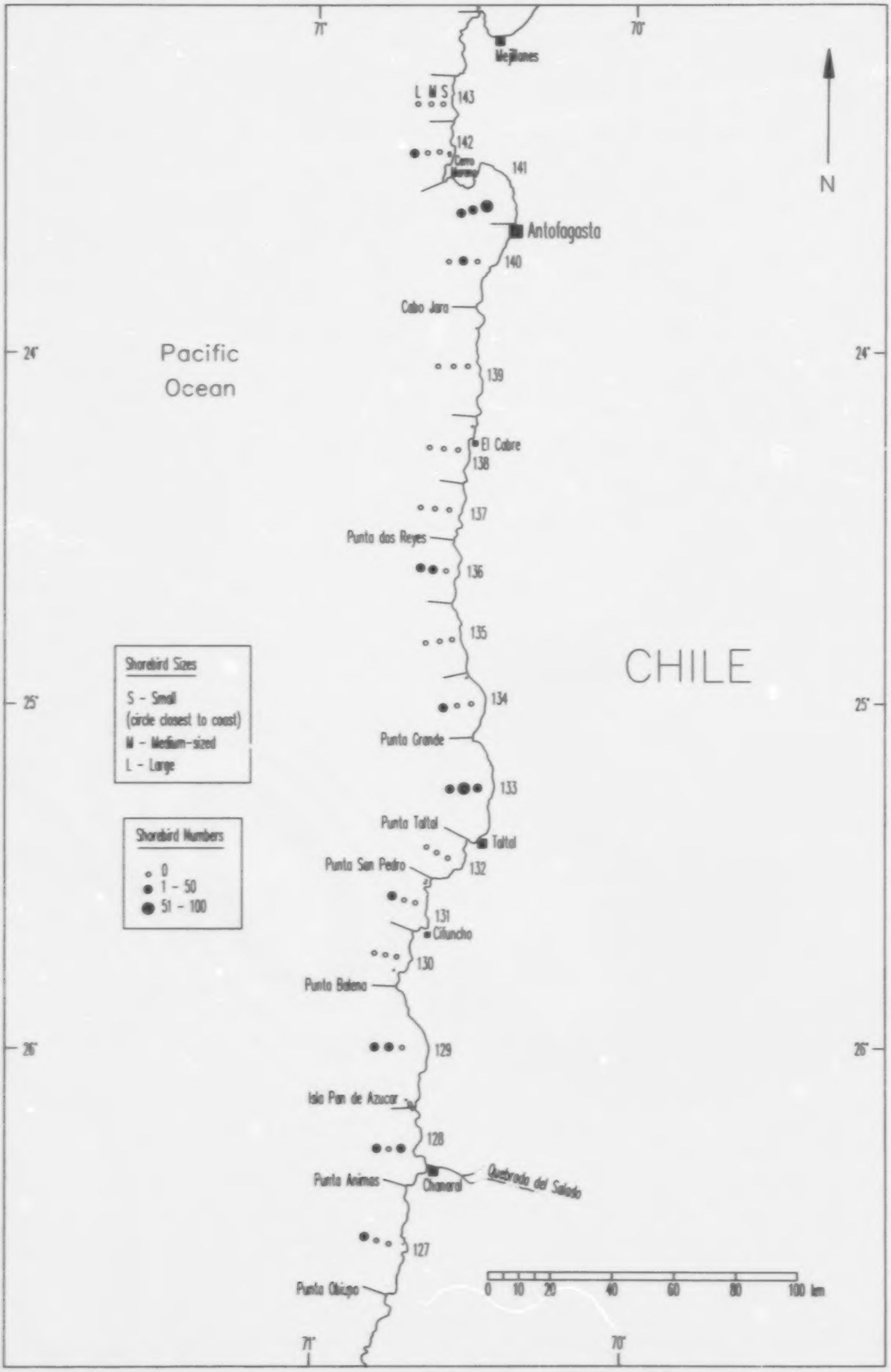
71°
70°
24°
25°
26°
Mejillones
L M S
143
142
Cerro Moreno
141
Antofagasta
140
Cabo Jara
Pacific Ocean
139
El Cobre
138
137
Punta dos Reyes
136
135
134
Punta Grande
133
Punta Taltal
Taltal
132
Punta San Pedro
131
Cifuncho
130
Punta Ballena
129
Isla Pan de Azucar
128
Punta Animas
Chanaral
Quebrada del Salado
127
Punta Obispo
N
CHILE
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
○ 0
● 1 - 50
● 51 - 100
0
10
20
40
60
80
100 km

Table 12.15
Totals of Nearctic shorebirds in survey sectors in Map 12.7 (Chile-7)

Sector no.	Sector length (km)	Sanderling	Total small shorebirds	Ruddy Turnstone	Surfbird	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
127	39.6	0	0	0	0	0	1	1	1
128	34.1	6	6	0	0	0	1	1	7
129	42.4	0	0	2	0	2	1	1	3
130	20.4	0	0	0	0	0	0	0	0
131	21.7	0	0	0	0	0	4	4	4
132	20.8	0	0	0	0	0	0	0	0
133	41.7	18	18	78	15	93	5	5	116
134	23.4	0	0	0	0	0	1	1	1
135	24.3	0	0	0	0	0	0	0	0
136	21.1	0	0	5	0	5	1	1	6
137	20.5	0	0	0	0	0	0	0	0
138	24.7	0	0	0	0	0	0	0	0
139	39.0	0	0	0	0	0	0	0	0
140	26.6	0	0	20	0	20	0	0	20
141	48.5	67	67	3	0	3	2	2	72
142	20.6	0	0	0	0	0	3	3	3
143	17.4	0	0	0	0	0	0	0	0
Total	486.8	91	91	108	15	123	19	19	233

Table 12.16
Principal habitats in survey sectors in Map 12.7 (Chile-7)

Sector no.	Habitat description
127	Low rocky shore, some sand and gravel beaches / dunes / sandy desert hillsides, barren mountains
128	Broad sand beaches, rocky points / hillsides with flat sand desert, mountains near shore
129	Jagged rocky shore, some sand beaches / steep hillside strewn with rocks, mountains
130	Steep rocks / barren rock-strewn hillsides rising directly to mountains
131	Low rocky shore, some sand beaches / flat sandy hinterland, hills
132	Low rocky shore with jagged sections, some sand beaches / flat sandy hinterland, hills
133	Both flat and steep rocky shores / sandy desert slopes rising to barren mountains
134	Rocky shoreline / barren rocky hillsides
135	Rocky shoreline / barren rocky hillsides
136	Rocky shoreline / barren rocky hillsides
137	Rocky shoreline, occasional gravel beach / barren sandy slopes
138	Bouldery shore / steep gravel slopes, mountains
139	Rocky shore / steep barren slopes, cliffs / mountains
140	Slab and boulder foreshore / very steep barren slopes, some cliffs / mountains
141	Sand and gravel beaches, some low rocky platforms / eroded cliffs / sand desert, hills
142	Rough rocky shoreline, some gravel beaches / sandy desert, mountains
143	Slab and boulder foreshore / cliffs / mountains

smaller patches of vegetation were noted in the valleys of the Quebrada de Triache, just north of Pisagua (Sector 161), and the Quebrada de Vitor (Sector 162). No water reached the ocean from these streams, and few shorebirds were seen, apart from 32 Whimbrels in Sector 162 (Table 12.19); large numbers of gulls were noted near the Rio Camarones and especially the Quebrada de Vitor.

The most notable stretch of coastline in the eco-unit comprised the long, sandy beaches north of Arica, towards the border with Peru (Sector 165). The mountain slopes and cliffs south of Arica gave way to a flat, sandy desert as the coast swung northwestwards. The sector total of 680 included 660 Sanderlings and 20 Black-bellied Plovers and represented 46.1% of the eco-unit total.

Map 12.8 (Chile-8)
Distribution of Nearctic shorebirds along the Iquique coast of Chile

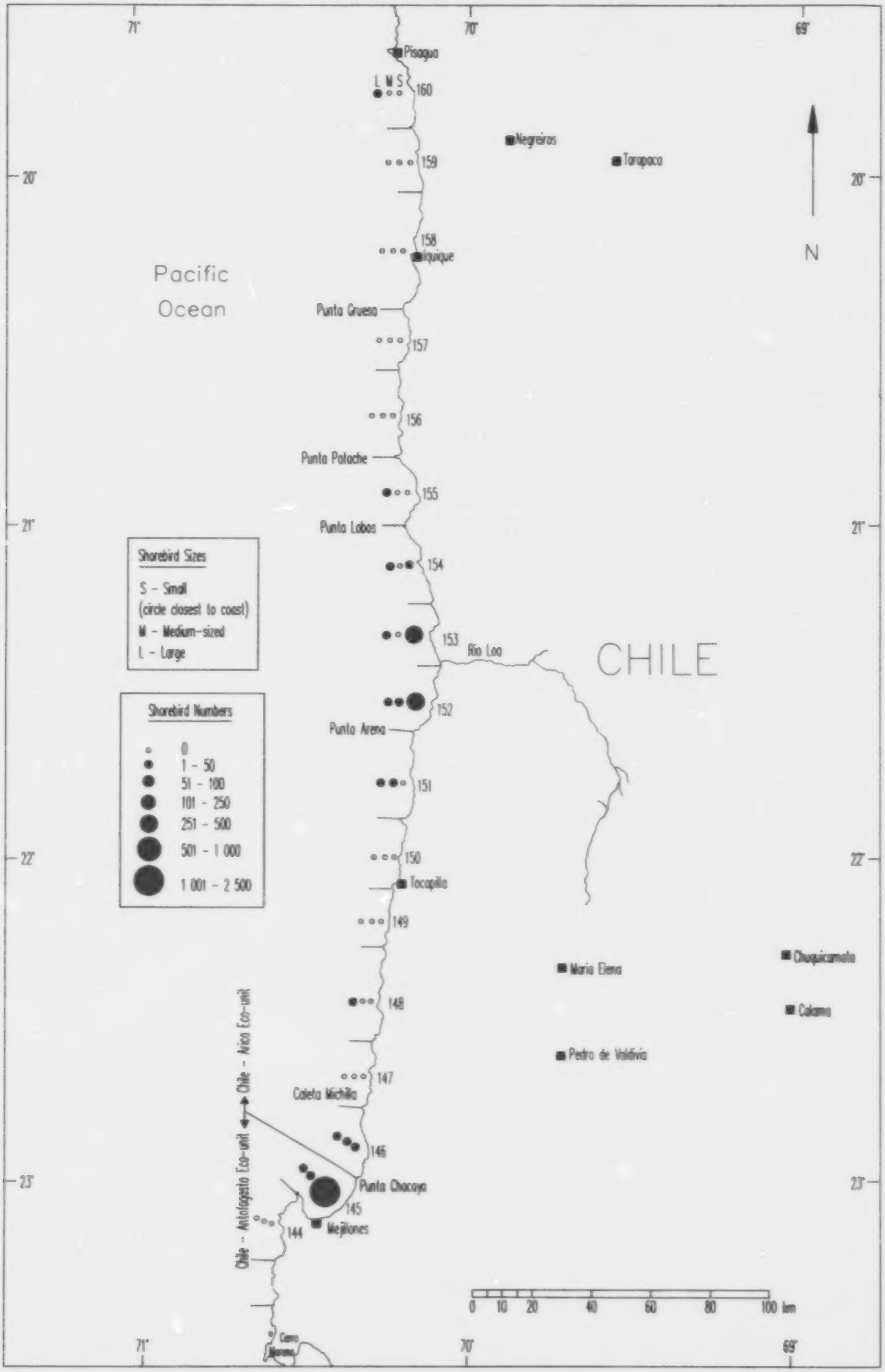
71°
70°
69°
20°
21°
22°
23°
Pisagua
L M S
160
159
158
Iquique
157
156
155
154
153
152
151
150
149
148
147
146
145
144
Negreiros
Tarapaca
N
Pacific
Ocean
Punta Gruesa
Punta Patache
Punta Lobos
Rio Loa
CHILE
Punta Arena
Tocopilla
Maria Elena
Chuquicamata
Calama
Pedro de Valdivia
Caleta Michilla
Punta Chacaya
Mejillones
Cerro Moreno
Chile - Arica Eco-unit
Chile - Antofagasta Eco-unit
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
0
10
20
40
60
80
100 km

Table 12.17
Totals of Nearctic shorebirds in survey sectors in Map 12.8 (Chile-8)

Sector no.	Sector length (km)	Sanderling	Total small shorebirds	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Surfbird	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
144	27.6	0	0	0	0	0	0	0	0	0	0	0	0
145	33.3	1 236	1 236	0	0	5	0	0	5	8	2	10	1 251
146	26.5	5	5	1	0	0	0	0	1	2	0	2	8
147	25.2	0	0	0	0	0	0	0	0	0	0	0	0
148	35.2	0	0	0	0	0	0	0	0	3	0	3	3
149	20.6	0	0	0	0	0	0	0	0	0	0	0	0
150	26.3	0	0	0	0	0	0	0	0	0	0	0	0
151	33.4	0	0	0	0	3	0	0	3	2	0	2	5
152	26.9	295	295	0	2	3	4	30	39	6	0	6	340
153	22.7	347	347	0	0	0	0	0	0	7	0	7	354
154	29.9	50	50	0	0	0	0	0	0	2	0	2	52
155	27.8	0	0	0	0	0	0	0	0	1	0	1	1
156	32.7	0	0	0	0	0	0	0	0	0	0	0	0
157	20.6	0	0	0	0	0	0	0	0	0	0	0	0
158	39.6	0	0	0	0	0	0	0	0	0	0	0	0
159	29.2	0	0	0	0	0	0	0	0	0	0	0	0
160	30.9	0	0	0	0	0	0	0	0	1	0	1	1
Total	488.4	1 933	1 933	1	2	11	4	30	48	32	2	34	2 015

Table 12.18
Principal habitats in survey sectors in Map 12.8 (Chile-8)

Sector no.	Habitat description
144	Gravel beaches with rocky sections / cliffs / mountains
145	Sand beach / steep sand slope / sand desert
146	Sand and gravel beaches, some jagged rocky stretches / steep rough sandy slopes rising to mountains
147	Rough rocky shoreline, some gravel beaches / abrupt rise to sandy desert, mountains
148	Rough rocky shore / barren desert slopes, mountains
149	Rough rocky shore / barren desert slopes, mountains
150	Rocky shores, gravel and boulder beaches / desert slopes, mountains
151	Rock slabs, gravel and boulder beaches / desert slopes, mountains
152	Rocky slabs, bouldery shore / desert slopes, mountains
153	Low rocky platforms, sand beaches / desert slopes, mountains
154	Low rocky platforms, sandbar, gravel beaches / desert slopes, mountains
155	Rough rocky shore, gravel beaches / sand-covered mountain slopes
156	Low rocky shore / sandy desert, hills, mountains
157	Low rocky shore / sandy desert hinterland, hills, mountains
158	Low rocky shore, some steep sections / sandy desert, barren mountain slopes
159	Steep gravel and rocky shore / barren mountain slopes
160	Steep gravel and rocky shore / barren mountain slopes

Map 12.9 (Chile-9)
Distribution of Nearctic shorebirds along the Arica coast of Chile

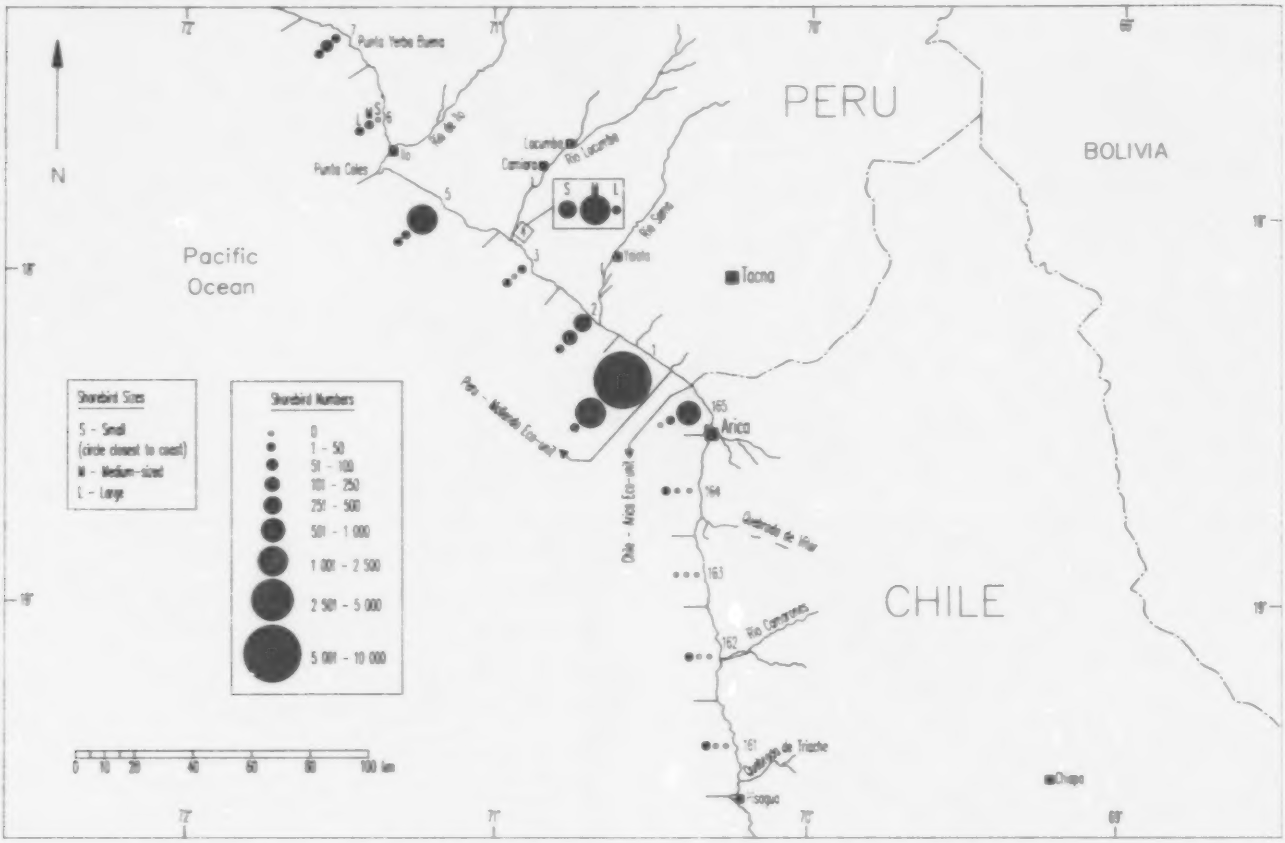
72°
71°
70°
69°
18°
19°
N
PERU
BOLIVIA
CHILE
Pacific
Ocean
Punta Yerba Buena
7
6
S
M
L
Ilo
Río de Ilo
Punta Coles
Locumba
Camiara
Río Locumba
5
4
3
2
1
Río Sama
Yaota
Tacna
165
Arica
164
163
162
161
Peru - Mollendo Eco-unit
Chile - Arica Eco-unit
Quebrada de Vitor
Río Camarones
Quebrada de Tiliviche
Pisagua
Chiapa
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
0
10
20
40
60
80
100 km

Table 12.19
Totals of Nearctic shorebirds in survey sectors in Map 12.9 (Chile-9)

Sector no.	Sector length (km)	Sanderling	Total small shorebirds	Black-bellied Plover	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
161	40.2	0	0	0	0	2	2	2
162	34.5	0	0	0	0	32	32	32
163	27.0	0	0	0	0	0	0	0
164	33.6	0	0	0	0	1	1	1
165	20.8	664	664	20	20	0	0	684
Total	156.1	664	664	20	20	35	35	719

Table 12.20
Principal habitats in survey sectors in Map 12.9 (Chile-9)

Sector no.	Habitat description
161	Bouldery shore, some rock slabs, sandy beaches / desert hinterland, mountains
162	Steep rocky coast, some sand and gravel beaches / cliffs / barren mountain slopes
163	Rocky and gravel shoreline / sheer gravel mountain slopes
164	Sheer rocky coastline, occasional rock slabs / mountain slopes
165	Sand beaches / irrigated fields, flat sandy desert

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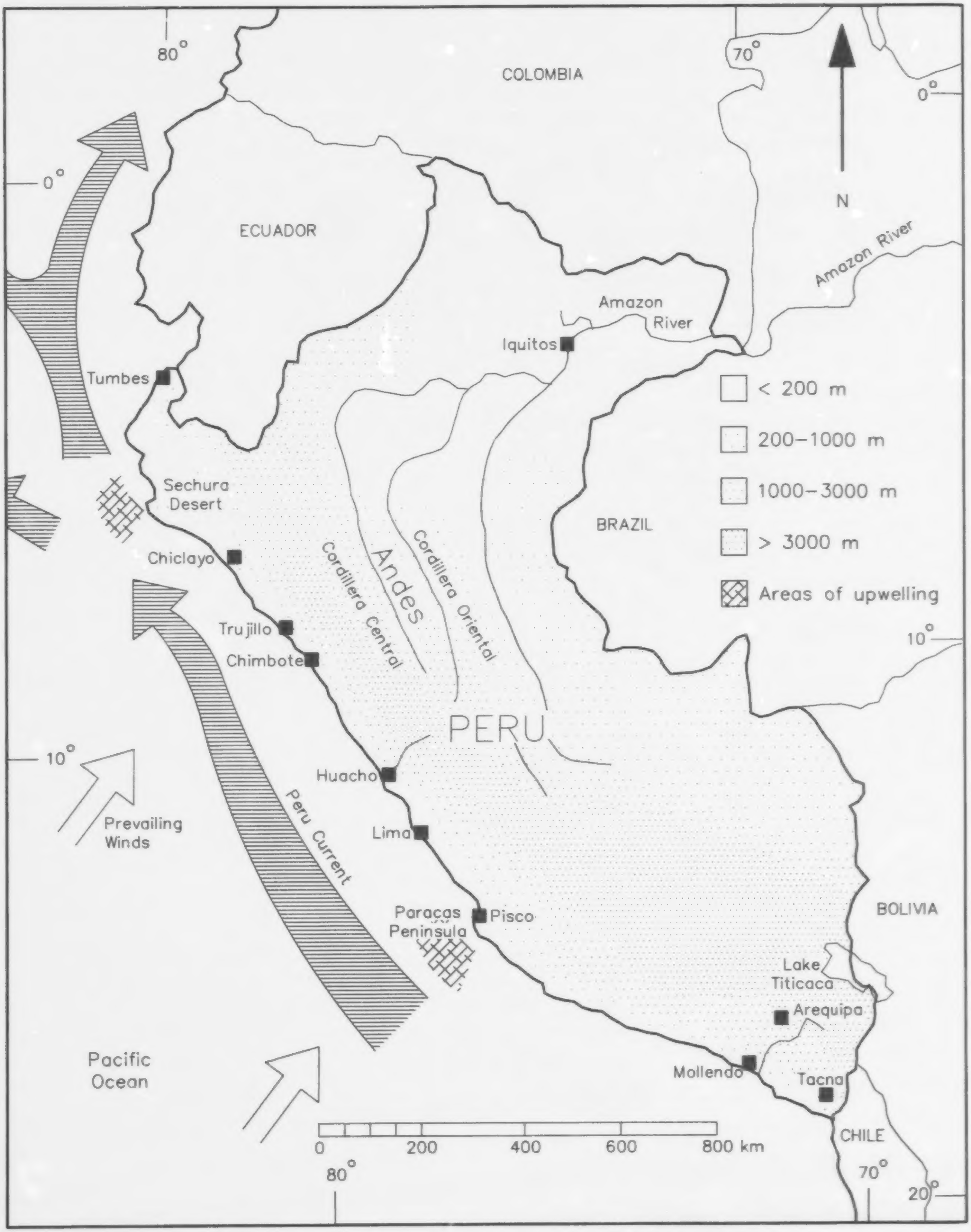
Figure 13.1
Some of the main geographical features of Peru


80°
COLOMBIA
70°
0°
N
ECUADOR
Amazon River
Amazon
River
Iquitos
Tumbes
< 200 m
200–1000 m
1000–3000 m
> 3000 m
Areas of upwelling
Sechura
Desert
BRAZIL
Chiclayo
Cordillera Central
Andes
Cordillera Oriental
Trujillo
Chimbote
10°
PERU
10°
Huacho
Prevailing
Winds
Peru Current
Lima
Paracas
Peninsula
Pisco
BOLIVIA
Lake
Titicaca
Arequipa
Pacific
Ocean
Mollendo
Tacna
0
200
400
600
800 km
CHILE
80°
70°
20°

Chapter 13

Peru

R.I.G. Morrison, R.K. Ross, C. Downes, and V. Pulido C.

13.1. General geography

The Republic of Peru covers an area of 1 285 000 km^2; it has a coastline of some 3080 km, extending from about 3 to 18°S along the west-central Pacific coast of South America (Scott and Carbonell 1986). Peru is bounded to the south by Chile, to the east by Bolivia and Brazil, to the north by Ecuador, and to the northeast by Colombia (Fig. 13.1).

Peru can be divided into three well-defined regions (Jenks 1975): (1) the Coastal Lowlands, a narrow, arid strip occurring between the Pacific coast and the lower slopes of the Andes; (2) the Cordillera de los Andes, three chains of mountains stretching the length of Peru; and (3) the Montanas (or Selva), which include the heavily forested eastern slopes of the Andes dropping to the jungle lowlands.

Each of these regions may be further subdivided (Jenks 1956). The Coastal Lowlands consist of the Andean coastal slope, forming the lower slope of the Pacific Andes reaching the coast between Camana and Atico; the Para-Andean depression, lying between the Andes and the Coast Range; and the Coast Range, which borders the Pacific in southern Peru. The Coast Range is steep in the southwest, whereas the northeast slopes are buried by the Para-Andean depression. Decreasing in elevation to the northwest, it is cut off by the coastline near Camana and continues in northwest Peru as offshore islands and, farther north, as a range of low mainland hills.

The Cordillera de los Andes can be divided into three mountain chains. The Cordillera Occidental, or the Western Cordillera, forms the continental divide from Ecuador to southern Peru. The other two chains, the Cordillera Central and the Cordillera Oriental of northern Peru, are less well defined and are separated by several high, wide plains, including the Pampa de Junin and the Lake Titicaca basin. Lake Titicaca itself is the largest lake in South America, covering an area of some 830 000 ha, of which approximately 430 000 ha are in Peru (Scott and Carbonell 1986).

The coast of Peru includes part of the world's largest coastal desert, the Atacama-Peruvian Desert, which extends from 7°S into northern Chile at 31°S (Petrov 1976). Spurs from the Western Cordillera either slope gradually towards the coast, to form small bare plateaus, or, between 9 and 13°S, fall steeply to the water's edge. The Peruvian coast is characterized by a cliffed shoreline, cut by marine erosion (Bird and Ramos 1985), alternating with sandy pocket beaches and beaches at river mouths. The sandy beaches are fed by marine sediments drifting shoreward or from cliff erosion and river sedimentation (Bird and Ramos 1985). The beaches are backed by large coastal sand dunes. The coast is simple in outline, with few estuaries or deltas. The vegetation is sparse, and the landscape is predominantly desert.

Apart from the Tumbes Department and some parts of the Piura Department in the far north, the coast is extremely arid (Dresch 1961). It is under the influence of the Peru (Humboldt) Current, with its supply of cold Antarctic water and cold water upwelling from the deep ocean, which combine to create a mild, uniform climate with low precipitation (Meigs 1966). Much of the Pacific slope of the Andes lies in a rainshadow and becomes progressively more arid as it nears the Pacific coast (Cobbing *et al.* 1981); the high cordillera acts as a barrier to easterly and southeasterly winds carrying precipitation.

The coast is cut by many transverse valleys with streams or rivers flowing towards the Pacific Ocean. Water in these rivers is derived from rain and snowmelt in the Andes, and river flow varies greatly throughout the year. The highest rates of flow are in the southern summer (October-April), with less or no flow during the winter. Only a few of the rivers reach the sea throughout the year. The lack of precipitation limits the input of sediments at the river mouths (Psuty and Mizobe 1982) and restricts estuarine development. A relatively lush vegetation can develop within the river valleys, and grasslands, marshes, and estuaries may result at the river mouths; such habitats provide important stopover points for migrant shorebirds on the long stretches of coastal desert (Hughes 1979). The rivers are also used to irrigate agricultural developments along the valley floors, in the deltas by the coasts, and on alluvial fans near the mountains.

The Peruvian coast can thus be characterized by its extreme aridity, moderate temperatures, and the unique juxtaposition of ocean and desert (Simons and Erickson 1953). It is an extremely dynamic coast, along which frequent tectonic activity causes minor changes. Much of the coast is currently eroding and developing a cliff face (Craig and Psuty 1968), whereas the rise of the sea has encroached on estuarine developments (Psuty and Mizobe 1982).

The geology of Peru has been reviewed by Newell (1949), Jenks (1956, 1975), Morrison (1962), and Cobbing *et al.* (1981); general texts have been provided by Bosworth (1922) and Steinmann (1930).

13.2. Coastal geomorphology

From the northern border with Ecuador (3°S) south to Trujillo (8°S), the coastal lowland forms a continuous plain with an abundant but poorly distributed supply of water, confined mostly to river valleys.

The Rio Zarumilla runs along the border between Peru and Ecuador. The northern plain between the Tumbes and the Piura rivers is elevated, and the rivers flow in deep valleys. The Rio Tumbes rises in Ecuador and has a substantial runoff. The large, sandy Tumbes delta on the southern shore of the Gulf of Guayaquil is bordered by mangroves (Bird and Ramos 1985). To the southwest, the coastline is cliffed, cut into uplifted Tertiary formations, and incised by transverse valleys (Bird and Ramos 1985).

To the south, the Rio Chira (5°S) interrupts a 50-km stretch of sandy beach backed by dunes, behind which lies a flat plain, which may be covered by high tides (Bird and Ramos 1985). The Rio Chira has the greatest annual flow (5500×10^6 m^3) of any river of the coastal desert of Peru (Meigs 1966). It rises in the mountains and lies within the southern margin of the tropical rains.

The Rio Piura marks the northern boundary of the Sechura Desert. It has a much smaller flow than either the Chira or the Tumbes rivers and a fluctuating water supply, which is not usually sufficient to reach the coast. A small estuary occurs at the mouth of the Rio Piura, bordered by sand spits; the bay is sandy and backed by cliffs (Bird and Ramos 1985). Irrigated oases are found on all the river plains, but their use is restricted by the small amount of land on the valley floors. The large inlet comprising the Virrila estuary contains extensive shallows and intertidal areas and provides important habitat for shorebirds and other birds.

Punta Aguja, at the southern end of the Bahia de Sechura, is a hilly peninsula cut by ravines and ephemeral stream channels, or wadis. Between Punta Negra, where the coast bends sharply southeastward, and Chiclayo, the seaward margin of the vast Sechura Desert forms a long, straight coastline of unbroken sandy beaches. From Chiclayo to Trujillo, the coastal plain narrows (Bird and Ramos 1985). Many deltas some 15–25 km in width are found along the southern part of the coastal plain at the mouths of short transverse rivers. At Chiclayo, the coastal plain is irrigated with water diverted from the Sana, Chancay, and de la Leche rivers. At Trujillo, alluvial fans have been irrigated for agriculture from the waters of the Moche and Chicama rivers.

Sand dunes reach impressive sizes along the central coast of Peru. Areas of beach with sand formations are frequently found at the southern margins of valleys (Psuty and Mizobe 1982). The largest and best known of these formations is the Purpur dune lying just south of Trujillo on a flat coastal plain bordered by a strip of cultivated land. This classically shaped dune is about 55 m high and 800 m wide. In recent years, the supply of sand that maintains the dune, which comes from the ocean and beach, has been cut off by cultivated land. This has resulted in the dune diminishing slightly in size, creating some concern for its preservation (Simons and Erickson 1953).

South of Trujillo, the Andean foothills approach the sea to form a steep coastline cut into Mesozoic rocks; there are many rocky, guano islands offshore. Sections of sandy beach backed by beach ridges also occur. South of Chimbote, the coastline is hilly and indented with bays cut into Cenozoic volcanics (Bird and Ramos 1985). Shore platforms occur, backed by cliffs. At Chimbote, the Peninsula de Ferrol consists of a high hill, with a rocky and indented coastal margin, attached to the mainland by a sandy isthmus. There is little shorebird habitat, except for a few isolated beaches. Between Chimbote and Culebras (9–10°S), "sand streams" are present. These formations consist of bands of coarse and fine-grained sands aligned parallel with the prevailing wind; they are relatively permanent features of the coastal desert because of the strong prevailing southwesterly winds. They occur in areas of low relief, near the sea where there are no barriers to the ocean winds. The supply of sand comes from the adjoining coastal beaches (Simons and Erickson 1953).

A scalloped, cliffy coastline occurs near Huarmey (10°S), indented by ravines and fringed by many guano islands and headlands. This region is rich in anchovies, which support a large population of terns, gulls, pelicans, and cormorants. A broad beach occurs along the coast, backed by a lagoon. Marshland is found on the delta plain of the river in Bahia de Huarmey; it is covered with brackish streams, marsh plants, and groves of algarrobo trees. Bare weathered hills border the river plain. Murphy (1936) reported that North American shorebird migrants were plentiful in the Huarmey oasis. Just to the south, a blunt delta occurs at the Rio Pativilca, and at Las Salinas there is a small barrier lagoon. At Playa Grande, the shoreline consists of a shingle beach backed by bluffs (Bird and Ramos 1985).

The Isla de Pescadores group of islands is found along the coast of Ancon (12°S); the islands are rough and irregular, with steep, jagged hills, narrow coves, and precipitous cliffs along the entire shoreline. No beaches are present, although there are some narrow flat areas covered with boulders (Murphy 1936). The mainland coast to the south is undulating, with small plains at valley mouths. Long beaches broken by steep headlands are found south of Lima.

The Paracas Peninsula (13–14°S) juts out into the Pacific at Pisco and marks the beginning of the coastal mountain range. It is largely made up of Carboniferous sediments, constituting one of the few such deposits in South America (Berry 1922). A detailed study of the geology and geomorphology of the marine desert coastal environment of the Paracas area has been conducted by Craig and Psuty (1968). The most striking coastal landforms are the high, rocky cliffs formed in granite and other igneous material and the narrow pocket beaches and bays developed in shales and shaley limestones. Areas where there is a sufficient supply of sediment to create beaches are quite restricted. Wide beaches occur sporadically, whereas the remainder of the coast has a thin covering of loose sand on a narrow shelf at the base of the coastal cliffs. North of Pisco, the Rio Chincha flows through a fertile valley, reaching the Pacific during the high-water period of January–May (US Naval Hydrographic Office 1968).

The Rio Pisco is the largest of the two major rivers draining the Paracas area. It drains an area of 3667 km^2 and has an average annual discharge of 28.7 m$^3 \cdot$s^{-1} (Craig and Psuty 1968). The flow of the river is sufficient to reach the Pacific only during sunny or rainy periods in the mountains. Much of the available water, however, is drained for irrigation purposes, and the lower course of the Rio Pisco remains a braided stream. During high water, sufficient sediment has been transported to the river mouth to create a fluvial delta fringed by a beach, providing suitable habitats for migratory shorebirds. A short distance inland, a series of beach ridges has formed (Craig and Psuty 1968). In the central part of the delta, there is a narrow, shallow lagoon between the delta and the beach. South of the river mouth, the beach remains very narrow and is backed by a low gravel wall.

Shingle beaches continue between the Rio Pisco and the town of Paracas, which lies in a cuspate foreland formed where two longshore currents converge. Sediments in the Bahia de Paracas are derived from both marine and land sources, and some sand and gravels are blown across the Paracas Peninsula into the bay. The sediment supply is generally low, and limited accretion occurs.

Crescent-shaped beaches, backed by cliffs or sheets of wind-blown sands, occur around the Paracas Peninsula and southwards along the coast. At Punta Zarate, a cuspate foreland encloses a lagoon and salt marsh (Bird and Ramos 1985). To the south, the beach widens into the broad flat coastal lowland plain, the Laguna Grande. Two spits have been built across the bay to the east coast of the Punta Carreta by the deposition of marine sediments. These spits restrict the amount of sediment that reaches the bay, and the beach is consequently quite narrow.

The coast between Bahia de la Independencia and the Rio Ica is dominated by crescent dunes. The Rio Ica is the second largest river in the Paracas area, draining an area of 1527 km^2, with an average annual discharge of 9.8 $m^3 \cdot s^{-1}$. As with the Rio Pisco, the flow rate is dependent on the rainy season in the lower slopes of the Andes. Because the flow is so variable, the Rio Ica may be classified as an intermittent stream, and there is no delta formation at its mouth. The coast around the Rio Ica receives a continuous supply of marine sediment, which is deposited on a narrow beach running for 20 km along the shoreline. Cliffs up to 70 m high occupy the more sheltered locations along the margins and heads of bays on the Paracas formation. Below the cliffs, a bedrock surface slopes towards the sea. This platform may be separated from the cliff by a beach, depending on the amount of sediment that is available.

South of the Paracas Peninsula, the coast bends to the southeast and is steep with many gullies, some of which reach the sea in small coves. The coast of southern Peru from Camana to northern Chile is desert, marked by only occasional river valleys. The 640 km of coast between Arequipa and Tacna consist of alternating flat shoreline exposed to heavy wave action and steep, rocky stretches. A small estuary occurs at the Rio Ocona, whereas the Rio Camana and the Rio Tambo have built deltas backed by bluffs, with a lagoon along the shoreline (Bird and Ramos 1985).

The Pampa de la Joya (16°45′S) is situated between the Pacific Ocean at Mollendo and the inland city of Arequipa. It is a broad, arid, level plain of coarse sand and fine gravel, bordered by the high Cerros de la Caldera, behind which rise the Andes (Finkel 1959). The western boundary is formed by the Rio Vitor, which bisects the Cerros de la Caldera and reaches the coast through a deep gorge. There is essentially no rainfall, and the humidity remains low, governed by the Rio Vitor. These physical features, combined with the strong oceanic prevailing winds, make the site ideal for the development of classical crescent dunes. A large part of the sand supply was deposited on the coastal shelf by volcanoes before the Quaternary. During the Quaternary, the coast was uplifted, the climate became more arid, and the sand began to blow northward. Recent volcanic activity around the 1600s added fibrous glass to the area; this is still present and indicates the recent age of the formation.

Coastal wetlands occurring at Mejia, near Mollendo (17°S), and at the exit of the Rio Locumba provide the last major stopover points for shorebirds along the barren southern Peruvian shoreline until the Rio Huasco, 1280 km to the south in the Atacama Desert of Chile (Hughes 1979).

South of Mejia to the Chilean border, the coast alternates between sandy beaches and rocky cliffs, and bluffs exposed to the sea. The area is cut by a number of ravines, through which small rivers filter towards the Pacific (US Naval Hydrographic Office 1968).

13.3. Climate

The coastline of Peru comprises one of the driest areas in the world. Annual rainfall is extremely low throughout the area: at Chimbote (9°S), for instance, it is 14 mm, and at Pisco (13°45′S) it averages only 2.2 $mm \cdot yr^{-1}$ (Johnson 1976). Coastal fogs are an important source of moisture (see Section 13.4).

Temperatures along the coast are relatively cool compared with others in areas of similar latitude. The mean annual temperature decreases from north to south, from 21°C at Talara (4°34′S) to 19°C at Callao, the port of Lima (12°S). Less variation occurs farther south (Johnson 1976). The mean daily summer maximum is about 26–28°C, whereas in the winter it is about 15–24°C. During the southern winter months, the sky generally has a thick cloud cover, and the diurnal temperature range is small (4–6°C in July). In the summer, the sky is usually clear, and the daily temperature fluctuation increases.

One of the most important phenomena affecting the climate of the coast of Peru is the Peru (Humboldt) Current, a shallow cold-water current flowing northwards along the western coast of South America. A wide range of literature exists on the nature and dynamics of the Peru (Humboldt) Current (e.g., Craig and Psuty 1968), but much remains to be understood. Oceanographers distinguish between the Peru Coastal Current, which flows along the coast to 150 km offshore, and the Peru Oceanic Current, which includes that part of the current flowing more than 150 km from the coast (US Naval Hydrographic Office 1968). The characteristic coldness of the coastal waters is a feature only of the Peru Coastal Current. The current maintains its coolness off the coast of Chile and Peru through the upwelling of cold, subsurface waters. The southeasterly trade winds are thought to carry the surface water away from the coast, drawing colder water from below to the surface (Wooster 1966). Craig and Psuty (1968), however, suggested that southwesterly winds are the cause. The upwelling is generally most intense along the coast of Peru and occurs in four main areas between 3 and 33°S (US Naval Hydrographic Office 1968). The main body of the Peru (Humboldt) Current leaves the coast south of the equator near the Gulf of Guayaquil in Ecuador and merges with the westward-flowing South Equatorial Current (US Naval Hydrographic Office 1968).

Another phenomenon exerting a major periodic influence on the weather and biological conditions along the coast of Peru is El Nino, which involves an invasion of warm water into the cooler coastal waters. This may be caused by shifts in prevailing wind patterns and results in drastic changes in the weather of the region, including excessive rainfall, which causes floods, erosion, and mudslides along the coast. Biological consequences include the loss of the anchovy population or avoidance of the affected waters by the anchovies, which in turn affects the seabird population, many of which either die or emigrate (Murphy 1936; Wooster 1966). Shorebird populations may also suffer if the effects extend to beach invertebrates, although few data are available.

13.4. Vegetation

Four major altitudinal zones may be distinguished among the vegetational communities of the coastline of Peru. From sea level to 1500 m, the landscape is barren, with pockets of seasonal vegetation; from 1500 to 2500 m, soil is present, and some vegetation exists; from 2500 to 4000 m, conditions are optimal for agriculture; and above 4000 m, the temperature becomes increasingly colder, and the grass pasturelands gradually die out (Cobbing *et al.* 1981). As the aridity decreases towards the north of Peru, the zonation pattern continues, but a scrubby vegetation develops at lower altitudes.

Much of the coastal desert has sparse to nonexistent vegetation, except for certain restricted areas (e.g., Macbride 1936). Cacti and succulents may be found on stony mountain slopes (Petrov 1976). Vegetation also occurs in formations known as *lomas*; these are areas of seasonal vegetation that obtain their moisture from the spring and winter fogs that occur throughout central and middle Peru (8–18°S) and in northern Chile (Brown 1968; Petrov 1976) and that disappear during the summer as the fogs disperse. No *loma* vegetation occurs north of 8°S, and the coast is essentially without precipitation between 8 and 4°S (Macbride 1936). The scrub vegetation of the northern Sechura Desert is not true *loma*, as it includes a number of grasses and other small plants that survive as seeds and flourish during rainfalls and therefore are not wholly dependent on the oceanic fog for moisture (Craig and Psuty 1968). The eastern boundary of *loma* formations is encountered where the Andean foothills rise abruptly above the altitude of the oceanic fog; in the west, *lomas* exist almost to sea level along the Pacific coast (Craig and Psuty 1968). *Lomas* are continuous between Arica, at the Chilean border, and Rio Lomas and are interrupted only by river valley vegetation. From Rio Lomas to Canete (13°S), *loma* vegetation is found only in a few places, e.g., along the Rio Ica and Bahia de San Nicolas. *Lomas* are again continuous to Pativilca, except for the river valleys; from there to Trujillo, they are restricted to certain areas and do not develop annually.

Loma vegetation consists mainly of annual herbs, with algae, lichens, cacti, succulents, and some shrubs and grasses. The dominant plant is the ground epiphyte *Tillandsia latifolia*, with *T. straminea* also being common (Macbride 1936; Craig and Psuty 1968; Psuty and Mizobe 1982).

The valleys that cross the coastal desert belt have zones of trees and shrubs along the banks of the rivers. These plants, which are not part of the *loma* formations, are dependent on groundwater for survival and include *Salix humboldtiana*, *Acacia macrantha*, *Prosopis limensis*, the algarrobo tree *P. chilensis*, and *Caesalpinia tara*. In the south, these trees and shrubs form a mixed riverbank brushwood (Macbride 1936).

In the areas of Piura and north Lambayeque, the rivers are bordered by broad algarroba groves. Outside the riverbanks in areas where there is no groundwater or where the water is highly saline, the desert has no plant life.

On the coast of the Tumbes Department north of 4°20′S, Macbride (1936) described the vegetation type as "rainy-green park landscape." The area consists of fields of herbs, columnar cacti, woody shrubs, and trees, the most common of which is *Loxopterygium huasango*. In years of heavy rain, the climber *Luffa operculata* develops to such an extent that it covers the small shrubs and trees. Herbaceous vegetation consists mainly of small annual grasses, which die out during the dry season. At the foot of the Andes, the hills are also covered with rainy-green landscape.

Mangrove formations reach their southern limit on the Pacific coast of South America at the delta of the Rio Tumbes. Mangroves are also found at the Rio Zarumilla, as well as the strand lying between the rivers. *Rhizophora mangle*, *Laguncularia racemosa*, and *Avicennia tomentosa* are all found in these formations (Macbride 1936). As with Colombian mangrove formations, the Peruvian mangrove is considered a high mangrove formation (West 1956), with *Rhizophora* reaching heights of up to 30 m, although there is no barrier sand beach characteristic of the Colombian formations.

13.5. Shorebird distribution

More than 115 000 Nearctic shorebirds were counted on the coast of Peru, including 89 700 small shorebirds (77.8%), 23 400 medium-sized shorebirds (20.3%), and 2200 large shorebirds (1.9%). The Peruvian total represented 52.8% of the regional Pacific Coast total and included 57.2, 68.1, and 8.1% of the regional totals for small, medium-sized, and large species, respectively (Table 13.1). The largest concentrations were found in eco-units in the southern half of the country, especially along the ocean beaches and isolated wetland areas and river mouths, and in the northern part of the country, particularly along the ocean beaches and in the Virrila estuary.

The ocean beaches of Peru formed one of the most important wintering areas in South America for Sanderlings *Calidris alba*; the total of 66 800 made up 74.5% of the small shorebirds in Peru and represented 68.1 and 59.8% of the Pacific Coast and South American totals for the species, respectively (Table 13.2*a*). The largest concentrations were generally found along beaches fronting deserts or near coastal lagoons or river mouths. In the south of the country, large numbers (over 6000) were found along the beaches just north of the border with Chile (Sector 1), where extensive deserts stretched inland towards Pampas de Socorro and Tacna. Somewhat smaller, but significant, numbers occurred along beaches associated with river mouths and/or coastal lagoons, such as those found south of Punta Coles (Sector 5), near the Mejia lagoons/Rio Tambo (Sectors 8 and 9), along the desert coasts between the Rio Yauca and Rio Acari (Sector 23), and north of Punta Lomitas (Sector 28). Major concentrations of Sanderlings occurred around the mouth of the Rio Pisco (7700, Sector 34) and on the gravel beaches south of the river and into the Paracas National Reserve (Sectors 32 and 33). Moderate numbers of Sanderlings were found on the long ocean beaches between Pisco and Lima (Sectors 35–39) and again north of Lima, particularly on those sections of coastline between Punta Lachay and Supe

Table 13.1
Summary totals of Nearctic shorebird species in eco-units in Peru

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Mollendo	683.9				
No. of birds		14 854	6 393	81	21 328
% of size-class total (Peru)		16.6	27.4	3.6	18.5
% of size-class total (South America)		0.64	1.40	0.07	0.73
% of size-class total (Pacific Coast)		9.48	18.64	0.29	9.76
% of grand total (Pacific Coast)		6.80	2.93	0.04	9.76
Lima	792.7				
No. of birds		19 995	2 335	988	23 318
% of size-class total (Peru)		22.3	10.0	44.2	20.2
% of size-class total (South America)		0.86	0.51	0.81	0.80
% of size-class total (Pacific Coast)		12.76	6.81	3.60	10.68
% of grand total (Pacific Coast)		9.15	1.07	0.45	10.68
Chimbote	426.1				
No. of birds		2 171	435	65	2 671
% of size-class total (Peru)		2.4	1.9	2.9	2.3
% of size-class total (South America)		0.09	0.10	0.05	0.09
% of size-class total (Pacific Coast)		1.39	1.27	0.24	1.22
% of grand total (Pacific Coast)		0.99	0.20	0.03	1.22
Chiclayo	871.6				
No. of birds		52 655	14 204	1 100	67 959
% of size-class total (Peru)		58.7	60.8	49.2	59.0
% of size-class total (South America)		2.26	3.11	0.91	2.33
% of size-class total (Pacific Coast)		33.61	41.41	4.00	31.11
% of grand total (Pacific Coast)		24.11	6.50	0.50	31.11
All Peru	2 774.3				
No. of birds		89 675	23 367	2 234	115 276
% of size-class total (Pacific Coast)		57.25	68.12	8.13	52.78
% of size-class total (South America)		3.85	5.11	1.84	3.95
% of grand total (South America)		3.07	0.80	0.08	3.95

(Sectors 43–47), where a number of lagoons occur near the coast. The few birds seen between Paramonga and Puerto Chicama (Sectors 50–60) were again found on desert coasts (e.g., north of Chimbote in Sector 55) or associated with beaches near river mouths (e.g., near Trujillo in Sector 58 and the Rio Chicama in Sector 59). The largest concentrations of Sanderlings in Peru occurred on the beaches south of Pacasmayo (11 100, Sector 61) as well as to the north of the town (3200, Sector 62). Significant numbers again occurred along the beaches and associated lagoon areas near Eten (Sectors 64 and 65). The very extensive ocean beaches fronting the Sechura Desert were one of the most important areas discovered for Sanderlings, with over 12 200 birds occurring in Sectors 66–69. The only significant numbers north of the Sechura Desert coastline were found north of the Rio Piura on the Bahia de Sechura in Sector 75. Although Sanderlings were often found in the general vicinity of river entrances, very few occurred in the near-coastal lagoons and wetlands themselves: only 1.6% of the Peruvian total was counted in the lagoons, with 98.4% on the beaches themselves.

The total of 22 800 small shorebirds consisted mostly of small sandpipers (peeps) in the genus *Calidris*, particularly Semipalmated Sandpipers *C. pusilla* and Western Sandpipers *C. mauri*, with smaller numbers of plovers in the genus *Charadrius*. Although small in terms of the overall South American total (1.0%) for this category, the total was regionally important, making up 39.0% of the Pacific Coast total (Table 13.2*a*). Relatively small numbers of birds were found in the coastal wetlands in the southern half of the country, with by far the largest numbers occurring in the Virrila estuary in northern Peru: this area held an estimated 20 000 small shorebirds, or 88.0% of the Peruvian total. Peeps were found almost exclusively in nearshore wetlands or river mouths and estuaries with intertidal areas: totals from the nine coastal wetland areas surveyed (Sectors 4, 10, 16, 45, 48, 65, 74, 78, and 85), together with those from the mouth of the Rio Pisco (Sector 34) and Virrila estuary (Sector 72), made up 99.7% of the Peruvian total (Table 13.3).

Peru was regionally important as a wintering area for medium-sized shorebirds, holding 68.1% of the Pacific Coast total for this category; the Peruvian total was, however, fairly moderate in continental terms (5.1% of the South American total for this category). Totals for Surfbirds *Aphriza virgata*, Black-bellied Plovers *Pluvialis squatarola*, Ruddy Turnstones *Arenaria interpres*, yellowlegs *Tringa* spp., and unidentified medium-sized shorebirds represented 39.1, 46.8, 81.1, 84.6, and 72.0% of their respective Pacific Coast totals (Table 13.2*b*). Yellowlegs were closely associated with coastal wetlands: the nine coastal wetlands surveyed contained 73.4% of the Peruvian total for the species, a figure that rose to 90.8% when totals for the wetlands at the mouth of the Rio Pisco and Virrila estuary were included (Table 13.3). These areas inclusively contained 46.8% of Black-bellied Plovers, 75.5% of unidentified medium-sized species, and 68.6% of the overall medium-sized totals in the country. The enormous importance of the Virrila estuary is reflected in its accounting for 87.7% of peeps, 44.0% of medium-sized shorebirds, and 49.8% of large species in Peru. Ruddy Turnstones, on the other hand, occurred principally along ocean beaches, with only 1.7% occurring in wetland areas: concentrations were scattered along the coast in roughly the same areas as Sanderlings, with highest sector totals occurring north of the Rio Pisco (400, Sector 35) and north of Pimentel at the southern end of the coast of the Sechura Desert (420, Sector 66). Black-bellied Plovers were also widely scattered in small numbers along the coast, with highest numbers occurring in the south of the country,

Table 13.2a
Totals of Nearctic shorebird species in eco-units in Peru—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Mollendo	683.9				
No. of birds		1	14 242	611	14 854
% of species total (Pacific Coast)		2.17	14.51	1.05	9.48
% of species total (South America)		0.23	12.74	0.03	0.64
% of size-class total (Pacific Coast)		0.00	9.09	0.39	9.48
% of grand total (Pacific Coast)		0.00	6.52	0.28	6.80
Lima	792.7				
No. of birds		1	18 831	1 163	19 995
% of species total (Pacific Coast)		2.17	19.18	1.99	12.76
% of species total (South America)		0.23	16.84	0.05	0.86
% of size-class total (Pacific Coast)		0.00	12.02	0.74	12.76
% of grand total (Pacific Coast)		0.00	8.62	0.53	9.15
Chimbote	426.1				
No. of birds		8	2 163	0	2 171
% of species total (Pacific Coast)		17.39	2.20	0.00	1.39
% of species total (South America)		1.86	1.93	0.00	0.09
% of size-class total (Pacific Coast)		0.01	1.38	0.00	1.39
% of grand total (Pacific Coast)		0.00	0.99	0.00	0.99
Chiclayo	871.6				
No. of birds		23	31 610	21 022	52 655
% of species total (Pacific Coast)		50.00	32.20	35.98	33.61
% of species total (South America)		5.34	28.27	0.95	2.26
% of size-class total (Pacific Coast)		0.01	20.18	13.42	33.61
% of grand total (Pacific Coast)		0.01	14.47	9.62	24.11
All Peru	2 774.3				
No. of birds		33	66 846	22 796	89 675
% of species total (South America)		7.66	59.78	1.03	3.85
% of size-class total (South America)		0.00	2.87	0.98	3.85
% of grand total (South America)		0.00	2.29	0.78	3.07

Table 13.2b
Totals of Nearctic shorebird species in eco-units in Peru—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Surfbird	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Mollendo	683.9						
No. of birds		587	156	45	961	4 644	6 393
% of species total (Pacific Coast)		20.43	6.63	22.84	40.58	18.53	18.64
% of species total (South America)		2.15	0.66	22.84	1.05	2.50	1.40
% of size-class total (Pacific Coast)		1.71	0.45	0.13	2.80	13.54	18.64
% of grand total (Pacific Coast)		0.27	0.07	0.02	0.44	2.13	2.93
Lima	792.7						
No. of birds		440	582	0	557	756	2 335
% of species total (Pacific Coast)		15.32	24.72	0.00	23.52	3.02	6.81
% of species total (South America)		1.61	2.48	0.00	0.61	0.41	0.51
% of size-class total (Pacific Coast)		1.28	1.70	0.00	1.62	2.20	6.81
% of grand total (Pacific Coast)		0.20	0.27	0.00	0.26	0.35	1.07
Chimbote	426.1						
No. of birds		114	259	30	30	2	435
% of species total (Pacific Coast)		3.97	11.00	15.23	1.27	0.01	1.27
% of species total (South America)		0.42	1.10	15.23	0.03	0.00	0.10
% of size-class total (Pacific Coast)		0.33	0.76	0.09	0.09	0.01	1.27
% of grand total (Pacific Coast)		0.05	0.12	0.01	0.01	0.00	0.20
Chiclayo	871.6						
No. of birds		203	911	2	455	12 633	14 204
% of species total (Pacific Coast)		7.07	38.70	1.02	19.21	50.40	41.41
% of species total (South America)		0.74	3.88	1.02	0.50	6.80	3.11
% of size-class total (Pacific Coast)		0.59	2.66	0.01	1.33	36.83	41.41
% of grand total (Pacific Coast)		0.09	0.42	0.00	0.21	5.78	6.50
All Peru	2 774.3						
No. of birds		1 344	1 908	77	2 003	18 035	23 367
% of species total (South America)		4.93	8.12	39.09	2.20	9.71	5.11
% of size-class total (South America)		0.29	0.42	0.02	0.44	3.95	5.11
% of grand total (South America)		0.05	0.07	0.00	0.07	0.62	0.80

Table 13.2c
Totals of Nearctic shorebird species in eco-units in Peru—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds
Mollendo	638.9					
No. of birds		79	1	1	0	81
% of species total (Pacific Coast)		0.84	0.02	0.01	0.00	0.29
% of species total (South America)		0.32	0.00	0.00	0.00	0.07
% of size-class total (Pacific Coast)		0.29	0.00	0.00	0.00	0.29
% of grand total (Pacific Coast)		0.04	0.00	0.00	0.00	0.04
Lima	792.7					
No. of birds		620	156	170	42	988
% of species total (Pacific Coast)		6.59	3.35	1.33	6.93	3.60
% of species total (South America)		2.49	0.35	0.37	0.64	0.81
% of size-class total (Pacific Coast)		2.26	0.57	0.62	0.15	3.60
% of grand total (Pacific Coast)		0.28	0.07	0.08	0.02	0.45
Chimbote	426.1					
No. of birds		65	0	0	0	65
% of species total (Pacific Coast)		0.69	0.00	0.00	0.00	0.24
% of species total (South America)		0.26	0.00	0.00	0.00	0.05
% of size-class total (Pacific Coast)		0.24	0.00	0.00	0.00	0.24
% of grand total (Pacific Coast)		0.03	0.00	0.00	0.00	0.03
Chiclayo	871.6					
No. of birds		169	431	0	500	1 100
% of species total (Pacific Coast)		1.80	9.26	0.00	82.51	4.00
% of species total (South America)		0.68	0.97	0.00	7.65	0.91
% of size-class total (Pacific Coast)		0.62	1.57	0.00	1.82	4.00
% of grand total (Pacific Coast)		0.08	0.20	0.00	0.23	0.50
All Peru	2 774.3					
No. of birds		933	588	171	542	2 234
% of species total (South America)		3.75	1.33	0.38	8.29	1.84
% of size-class total (South America)		0.77	0.48	0.14	0.45	1.84
% of grand total (South America)		0.03	0.02	0.01	0.02	0.08

Table 13.3
Numbers of Nearctic shorebirds seen in coastal wetlands and wetland habitats in the mouth of the Rio Pisco and Virrila estuary during aerial surveys of the coast of Peru, early February 1986

Category/species	Wetlands only[a]	% Peruvian total	Wetlands plus Rio Pisco plus Virrila estuary[a]	% Peruvian total
Small species	1 872	8.2	22 734	99.7
Spotted Sandpiper	14	42.4	14	42.4
Sanderling	1 050	1.6	9 050	13.5
Total small species	2 936	3.3	31 798	35.5
Medium-sized species	3 321	18.4	13 621	75.5
Black-bellied Plover	628	46.7	629	46.8
Ruddy Turnstone	31	1.6	32	1.7
Surfbird	0	0	0	0
Yellowlegs species	1 470	73.4	1 818	90.8
Total medium-sized species	5 387	23.1	16 029	68.6
Large species	40	7.4	540	99.6
Whimbrel	24	2.6	79	8.5
Willet	193	32.8	393	66.8
Hudsonian Godwit	1	0.6	101	59.4
Total large species	258	11.4	1 113	49.8

[a] Coastal wetland areas include Sectors 4, 10, 16, 45, 48, 65, 74, 78, and 85; mouth of the Rio Pisco = Sector 34; Virrila estuary = Sector 72.

particularly in the coastal lagoons (totals of 120, 110, and 240 in Sectors 4, 10, and 16, respectively); the highest sector total (260) occurred at Paracas (Sector 32).

Numbers of large shorebirds in Peru were again relatively modest, the size-class total representing 8.1 and 1.8% of the Pacific Coast and South American totals, respectively (Table 13.2*c*). The most numerous species were the Whimbrel *Numenius phaeopus* (930) and Willet *Catoptrophorus semipalmatus* (580), with 9.9 and 12.6% of the regional totals, respectively. Whimbrels occurred mostly along ocean beaches, generally in fairly small concentrations, and were most numerous between Pisco and Lima. Willets were most common in northern Peru, particularly in the Virrila estuary and Rio Piura wetlands, with coastal wetlands and river mouths accounting for 66.8% of the total (Table 13.3). Willets were also seen regularly along the coast between Pisco and Lima. The 170 Hudsonian Godwits *Limosa haemastica* seen at and to the north of the mouth of the Rio Pisco were the most northerly observation of the species on the Pacific coast.

13.5.1. Mollendo eco-unit

Sectors 1–23; Maps 13.1 (Peru-1) to 13.3 (Peru-3)

The Mollendo eco-unit stretches from the border with Chile northwestwards along the coast to near Puerto de Lomas, just beyond the Rio Acari. The eco-unit total of 21 300 (18.5% of the Peruvian total) included important concentrations of Sanderlings (14 200, 14.5% of the Pacific Coast total) and medium-sized species (6400, 18.6% of the Pacific Coast total), including Black-bellied Plovers, Ruddy Turnstones, Surfbirds, and yellowlegs (20.4, 6.6, 22.8, and 40.6% of the respective Pacific Coast totals). The desert coastline generally consisted of sand beaches, some of which were heavily used by Sanderlings, alternating with steeper, rockier sections. Several isolated coastal wetlands occurred near the mouths of rivers, where blunt deltas have formed in the face of the heavy onshore ocean swell, including those at Rio Locumba, the Mejia Lagoons at the Rio Tambo, and those at the Rio Camana. These areas provide important habitats for shorebirds.

The coastline immediately north of the border with Chile was very flat (Sectors 1 and 2), consisting of sandy ocean beaches backed by a sand desert stretching inland (Table 13.5). Major concentrations of Sanderlings (6200) occurred in Sector 1, the sector density of 240 birds per kilometre being one of the highest recorded for the species in South America (Table 13.4). Large numbers of medium-sized shorebirds also occurred among the flocks of Sanderlings and gulls, many of which were most likely turnstones, identification being complicated by the very bright light. Occasional rocky outcrops were found along the beaches in Sector 2, and many of the smaller flocks of birds encountered in this sector appeared to be associated with that habitat, including Black-bellied Plovers, turnstones, and Surfbirds. The coastline became rockier in Sector 3, the low rocky foreshore being backed by steep sandy slopes rising to the mountains inland; the only shorebirds (24 Sanderlings, four Whimbrels) were found along a sandy beach near the mouth of the Rio Locumba.

Sector 4 comprised the coastal wetlands at the mouth of the Rio Locumba. The wetlands appeared to be very polluted with industrial effluent, many ponds being heavily stained, but nevertheless supported moderate numbers of peeps (260) and a variety of medium-sized shorebirds, particularly Black-bellied Plovers and yellowlegs.

Much of the southern part of Sector 5 was rocky, backed by sandy desert slopes or a low stratified cliff. The long, straight sandy beach running up to Punta Coles, the Playa El Palo, was backed by a bluff cut into the gravelly pediment forming the Pampa de El Palo (Bird and Ramos 1985); it supported most of the shorebirds, including 1700 Sanderlings, seen in the sector.

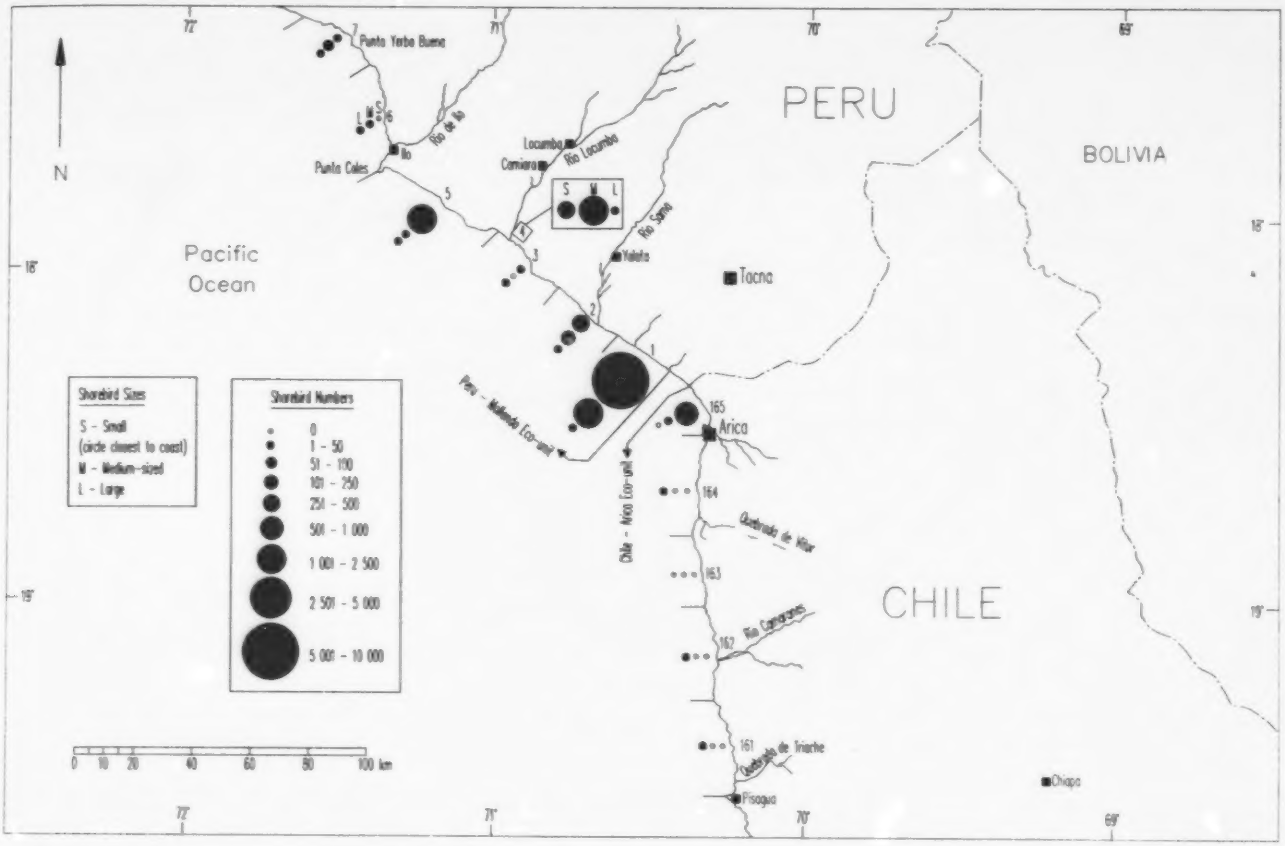
The rocky coastline continued in Sectors 6 and 7, with occasional sections of gravel or sand beach and correspondingly low numbers of shorebirds.

The coast opened out somewhat at Sector 8, which marked the beginning of a long ocean beach running all the way through Sector 9 to Mejia, and further to Mollendo (Sector 11; Table 13.7). Some small wetlands occurred behind the coast in Sector 8. Sanderlings were common on the ocean beaches in Sectors 8 (640) and 9 (1300; 120 birds per kilometre), particularly just north of the mouth of the Rio Tambo (Sector 9), although relatively few (80) were seen in Sector 11 between Mejia and Mollendo (Table 13.6); gulls and terns were numerous along the beaches. The major wetlands in the area, the Mejia Lagoons (Sector 10), comprise the Santuario Nacional Lagunas de Mejia and are found north of the mouth of the Rio Tambo. The lagoons contain a variety of habitats (Pulido 1982), including ponds with both open and marshy shores, and have been formed where the Rio Tambo has built a blunt delta. Moderate numbers of shorebirds were found in the lagoons themselves (total 1100) during the surveys, although the area is known to be of outstanding importance to shorebirds, particularly during migration, providing a combination of beach and wetland habitats, which occurs at only a very few places in southern Peru and Chile (Hughes 1979).

Long stretches of the coastline between Mollendo and the end of the eco-unit near Puerto de Lomas consisted of steep, rocky shoreline, and the sections of coast containing such habitats (Sectors 12, 13, and 17–21) held very few, if any, Nearctic shorebirds. Mollendo marks the beginning of a coastal mountain range extending northwards to the Paracas Peninsula (Noble *et al.* 1978). The only concentrations of shorebirds found were on sections of sandy beaches and/or near river mouths and associated wetlands, such as those occurring in Sectors 14–16 in the vicinity of the Rio Camana and in Sectors 22 and 23 (Tables 13.8 and 13.9), containing the Rio Yauca and Rio Acari, respectively. Sanderlings were quite common on the sandy beaches in the south of Sector 14, as well as in the northern part near the Rio Camana on the gravel beaches north of the river mouth in Sector 15, where the shoreline is backed by extensive agricultural wetlands, consisting mostly of rice fields. The river here has built a blunt delta, with beach ridges and swale lagoons. The Rio Camana wetlands (Sector 16), in fact, contained the highest number of shorebirds (2400) counted in the nine coastal lagoon systems censused on the coast of Peru. Yellowlegs were the most numerous species identified, the total of 900 representing some 37.9% of the total for the Pacific Coast, and Black-bellied Plovers (240) were also common.

In Sector 22, Sanderlings occurred on sandy beaches near the river mouth north of Chala, although much of the remaining coastline was steep and rocky. A long sandy beach began at Tanaca, running for over 50 km to the end of the sector north of Puerto de Lomas; the coastline opened up north of the Rio Yauca into a vast desert stretching inland. A few small ponds occurred behind the shoreline near the mouths of the Rio Yauca and

Map 13.1 (Peru-1)
Distribution of Nearctic shorebirds along the southern coast of Peru



PERU
BOLIVIA
CHILE
Pacific Ocean
N
Punta Yerba Buena
Ilo
Punta Coles
Río de Ilo
Locumba
Camiara
Río Locumba
Río Sama
Yalata
Tacna
Arica
Peru - Mollendo Eco-unit
Chile - Arica Eco-unit
Quebrada de Vitor
Río Camarones
Quebrada de Tiliviche
Pisagua
Chiapa
S
M
L
1
2
3
4
5
6
7
161
162
163
164
165
72°
71°
70°
69°
18°
19°
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
0
10
20
40
60
80
100 km

Table 13.4
Totals of Nearctic shorebirds in survey sectors in Map 13.1 (Peru-1)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Surfbird	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
1	25.6	6 187	0	6 187	0	12	0	0	1 700	1 712	5	5	7 904
2	25.6	380	0	380	30	67	40	0	100	237	7	7	624
3	33.9	24	0	24	0	0	0	0	0	0	4	4	28
4	12.6	0	260	260	120	5	0	22	1 089	1 236	3	3	1 499
5	49.8	1 730	1	1 731	0	30	0	0	0	30	5	5	1 766
6	41.4	0	0	0	0	29	3	0	0	32	10	10	42
7	33.0	30	0	30	52	3	1	0	0	56	3	3	89
Total	221.9	8 351	261	8 612	202	146	44	22	2 889	3 303	37	37	11 952

Table 13.5
Principal habitats in survey sectors in Map 13.1 (Peru-1)

Sector no.	Habitat description
1	Sand beach / flat sand desert
2	Sand beach, occasional rock outcrop / flat sand desert
3	Rocky coast, some sand beaches / sandy hill slopes, mountains
4	Inland; polluted wetlands, marshy ponds / sandy desert
5	Sand beach changing to rocky shore / steep sandy desert slope, mountains
6	Rocky coastline, some gravel beach / sandy desert hillsides, mountains
7	Mostly rocky shore with rock and sand beaches in bays / steep desert hillside, mountains

Map 13.2 (Peru-2)
Distribution of Nearctic shorebirds along the Mollendo coast of Peru

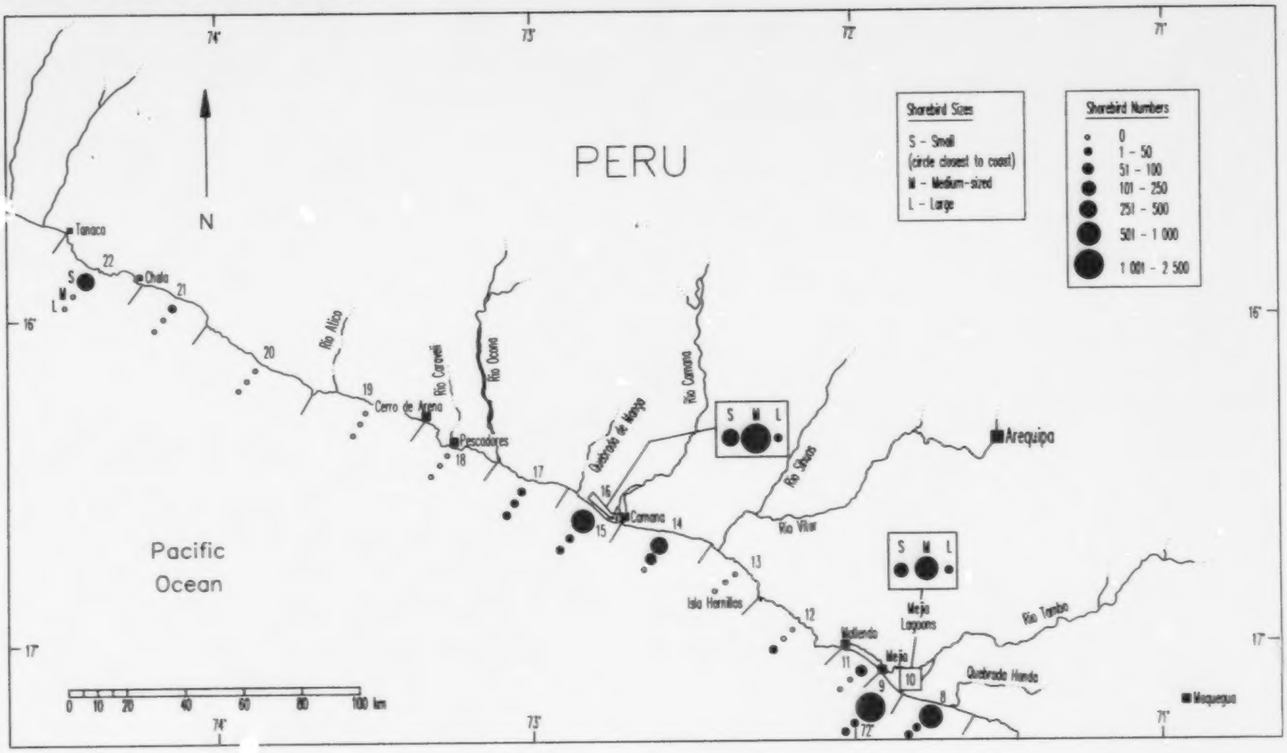

74°
73°
72°
71°
16°
17°
PERU
N
Pacific Ocean
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
Tanaca
Chala
Rio Atico
Cerro de Arena
Rio Caraveli
Rio Ocona
Pescadores
Quebrada de Mango
Rio Camana
Camana
Rio Siguas
Rio Vitor
Arequipa
Isla Hornillos
Mollendo
Mejia
Mejia Lagoons
Rio Tambo
Quebrada Honda
Moquegua
S
M
L
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
0 10 20 40 60 80 100 km

Table 13.6
Totals of Nearctic shorebirds in survey sectors in Map 13.2 (Peru-2)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Surf-bird	Yellow-legs species	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Hudson-ian Godwit	Total large shore-birds	Total shore-birds
8	22.5	0	635	0	635	7	3	0	0	15	25	8	0	0	8	668
9	10.9	0	1 310	0	1 310	10	0	0	0	0	10	14	0	0	14	1 334
10	12.1	1	200	0	201	110	0	0	13	801	924	10	0	1	11	1 136
11	13.1	0	80	0	80	0	0	0	0	0	0	0	0	0	0	80
12	41.6	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
13	27.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	30.8	0	454	0	454	15	1	0	15	25	56	0	0	0	0	510
15	18.2	0	660	0	660	7	0	0	2	5	14	2	0	0	2	676
16	13.1	0	50	350	400	235	1	0	898	909	2 043	2	0	0	2	2 445
17	28.3	0	5	0	5	0	0	1	0	0	1	6	0	0	6	12
18	35.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	41.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	47.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	25.8	0	15	0	15	0	0	0	0	0	0	0	0	0	0	15
22	39.4	0	440	0	440	0	0	0	0	0	0	0	0	0	0	440
Total	408.2	1	3 849	350	4 200	384	5	1	928	1 755	3 073	42	1	1	44	7 317

Table 13.7
Principal habitats in survey sectors in Map 13.2 (Peru-2)

Sector no.	Habitat description
8	Sand beaches / barren sandy hillsides, scattered vegetation, some marshy areas
9	Sand beach / lagoon behind beach / desert, hills, mountains
10	Inland; wetlands with both open and marshy shore / sandy hill slopes, mountains
11	Steep rocky coastline / rocky slopes, mountains
12	Ocean beach / irrigated fields / sandy slopes, mountains
13	Rocky coast / some cliffs / salt-stained hills, mountains
14	Sand and gravel beaches, some rocky sections / sand bluffs, eroding cliffs / some farmland, wetlands, sandy hills, mountains
15	Gravel beaches / wetlands and farmland, sandy hills, mountains
16	Inland; marshy wetlands, rice fields / farmland, desert, hills, mountains
17	Sand and gravel beaches changing to steep rocky shore / desert, hills, mountains
18	Rocky, steep cliff coastline / desert slopes, mountains
19	Rocky shoreline, occasional sand and gravel beaches / steep rocky slopes above shore, desert, mountains
20	Rocky shore / desert slopes, mountains
21	Sand and gravel beach / sandy clifflets / broad desert, mountains
22	Jagged rocky headlands and coast, sand beaches / broad desert, mountains

Rio Acari. Sanderlings (total 2000) were scattered all along the ocean beach north of the Rio Yauca.

13.5.2. Lima eco-unit

Sectors 24–46; Maps 13.3 (Peru-3) and 13.4 (Peru-4)

The Lima eco-unit stretches from Puerto de Lomas to beyond Huacho, north of Lima. The eco-unit total of 23 300 represented 20.2% of the shorebirds counted in Peru and included significant numbers of small shorebirds (20 000, 22.3% of the Peruvian total), especially Sanderlings (18 800, 19.2% of the Pacific Coast total), as well as moderate numbers of medium-sized (2300) and large (990) species (Table 13.2). The total for medium-sized shorebirds, although modest (6.8% of the Pacific Coast total), included notable numbers of the identified species totals for Black-bellied Plovers (440), Ruddy Turnstones (580), and yellowlegs, representing 15.3, 24.7, and 23.5% of the respective Pacific Coast totals. Among large species, Whimbrels were numerous, the eco-unit containing 66.5% of the Peruvian total. The only flocks of Hudsonian Godwits observed north of the principal Pacific coast wintering grounds in the south of Chile were near the mouth of the Rio Pisco.

Important habitats in the eco-unit included some sections of ocean beach between San Juan and the Paracas Peninsula, the stretch of coast between Bahia de Paracas and the Rio Pisco, the ocean beaches between Pisco and Lima, and the lagoons and beaches between Punta Lachay and Huacho north of Lima.

The coastal mountain range extending through the southern part of the eco-unit between Puerto de Lomas and the Paracas Peninsula results in a generally steep shoreline in Sectors 24–31 (Table 13.9). Much of the coastline is sandy under the influence of the onshore oceanic swell, and drifting sand has blocked the mouth of the Rio Ica valley. In some places, pebble or gravel beaches are found, formed from material derived from Pleistocene conglomerates deposited at old valley mouths (Bird and Ramos 1985).

The shoreline in Sector 24 was generally rocky, with headlands and some small beaches: 100 Sanderlings were observed in the sector on the beaches near San Juan (Table 13.8). The two bays making up Sector 25, Bahia San Juan and Bahia San Nicolas, are asymmetrical as a result of refraction of the southwesterly swell around the protecting headlands. Sandy beaches are found in the inner, sheltered parts of the bay, whereas rockier coasts are found towards the more northern parts. The shorebirds found in Sector 25 occurred on the beaches, the medium-sized birds in Bahia San Juan (170), and the Sanderlings (140) and Whimbrels (65) in Bahia San Nicolas. No Nearctic shorebirds were recorded in Sector 26, which contained a steep rocky shoreline with some sand and gravel beaches.

The coastline became very sandy in Sector 27. In the southern part of the sector around the mouth of the Rio Ica valley, the beach was backed by dunes with little or no vegetation, and the direction of the prevailing southwesterly winds was evident from the alignment of the blown sand trailing inland. Long sandy beaches continued north of the river valley, backed by steep, sandy hill slopes. A short section was missed owing to coastal fog; 240 Sanderlings were recorded along the beaches. The sandy coastline continued throughout Sector 28, with some rocky outcroppings, and large numbers of Sanderlings (2100) were scattered throughout the sector. Another asymmetrical bay, resulting from the refraction of the swell around the headland, occurs north of Punta Lomitas.

Bahia Independencia (Sector 29) was flanked by rocky headlands and contained sand and some gravel beaches along its shoreline and the partially enclosed Laguna Grande at its northern end; the most notable sighting of shorebirds involved a flock of 220 Whimbrels. Similar habitat continued in Sector 30, becoming rockier and steeper near the Paracas Peninsula in Sector 31; very few Nearctic shorebirds were encountered in these sectors.

The coast between Bahia de Paracas, on the north side of the Paracas Peninsula, and the Rio San Juan, just north of Pisco, was very important for Nearctic shorebirds, supporting the largest concentrations found in the southern half of Peru (Table 13.8). The sandy shoreline and intertidal flats of Bahia de Paracas (Sector 32), making up the Reserva Nacional de Paracas, contained moderate numbers of Sanderlings (460) and medium-sized shorebirds, including Black-bellied Plovers (260) and yellowlegs (150). Substantial numbers of Sanderlings (1400) were found on the sand and gravel beaches running north between Paracas and Pisco (Sector 33). The highest concentrations of shorebirds were found in the mouth of the Rio Pisco itself (Sector 34). The river, which was actively flooding, has formed a fairly extensive delta with a complex of sandflats and gravel bars, behind which is enclosed a series of lagoons and vegetated pools. Large numbers of small shorebirds were found roosting in the delta, including some 7700 Sanderlings and over 680 peeps, as well as smaller numbers of medium-sized shorebirds, including 340 yellowlegs, and larger shorebirds. The 170 Hudsonian Godwits found in the river mouth (100) and nearby sections of Sector 35 (70) were the largest concentrations found on the Pacific coast outside the main wintering area in Chiloe. A long sand beach stretched northwards from the river mouth. Ponds were found behind the shoreline just north of the river, followed by green, irrigated agricultural land, which continued north of the North Chincha River, where chicken farms lined the shore. Sanderlings (1300) and Ruddy Turnstones (400) continued to be common along the shoreline, with smaller numbers of

Map 13.3 (Peru-3)
Distribution of Nearctic shorebirds along the Paracas coast of Peru

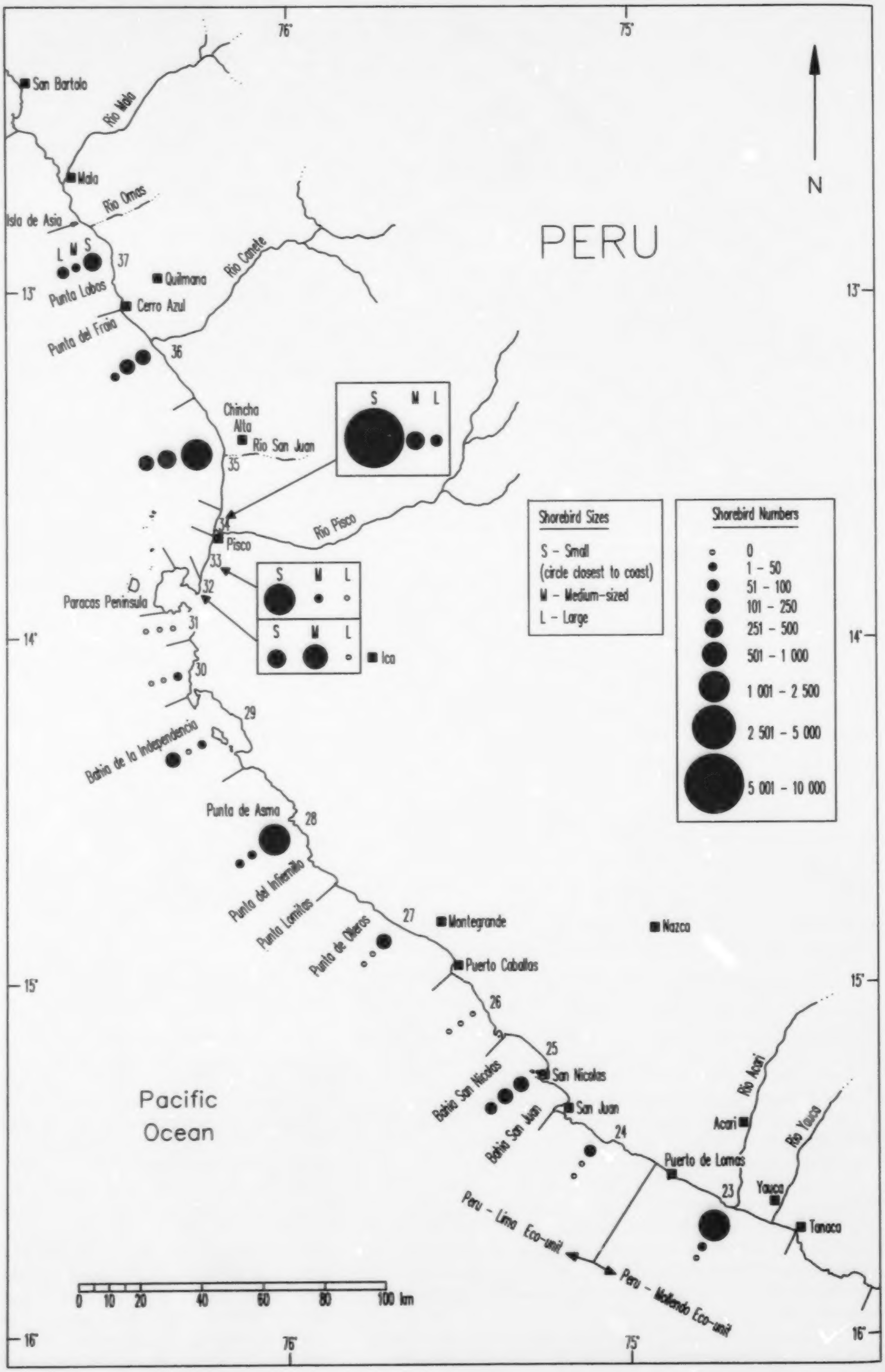

76°
75°
N
PERU
San Bartolo
Rio Mala
Mala
Rio Omas
Isla de Asia
L M S
37
Quilmana
Rio Canete
Punta Lobos
13°
Cerro Azul
Punta del Fraia
36
Chincha Alta
Rio San Juan
35
S M L
34
Pisco
Rio Pisco
33
32
S M L
Paracas Peninsula
31
S M L
Ica
14°
30
29
Bahia de la Independencia
Punta de Asma
28
Punta del Infiernillo
Punta Lomitas
Punta de Olleros
27
Montegrande
Nazca
Puerto Caballas
15°
26
25
San Nicolas
Bahia San Nicolas
San Juan
Bahia San Juan
24
Rio Acari
Acari
Rio Yauca
Puerto de Lomas
Yauca
23
Tanaca
Peru - Lima Eco-unit
Peru - Mollendo Eco-unit
Pacific Ocean
0 10 20 40 60 80 100 km
16°
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000

Table 13.8
Totals of Nearctic shorebirds in survey sectors in Map 13.3 (Peru-3)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Hudsonian Godwit	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
23	53.8	2 042	0	2 042	1	5	11	0	17	0	0	0	0	0	2 059
24	41.4	100	0	100	0	0	0	0	0	0	0	0	0	0	100
25	45.7	137	0	137	0	0	0	173	173	65	0	0	0	65	375
26	29.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	52.2	236	0	236	0	0	0	0	0	0	0	0	0	0	236
28	58.0	2 110	0	2 110	0	5	0	9	14	5	0	0	0	5	2 129
29	44.1	10	0	10	0	0	0	0	0	220	0	0	0	220	230
30	20.1	7	0	7	0	0	0	0	0	0	0	0	0	0	7
31	44.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	23.8	455	0	455	260	0	150	150	560	0	0	0	0	0	1 015
33	14.7	1 400	0	1 400	0	1	0	5	6	0	0	0	0	0	1 406
34	7.0	7 700	862	8 562	1	1	340	30	372	0	0	100	0	100	9 034
35	40.2	1 280	50	1 330	0	396	3	0	399	31	3	70	2	106	1 835
36	38.6	177	3	180	5	44	4	50	103	18	3	0	0	21	304
37	34.2	368	1	369	1	6	0	0	7	25	30	0	0	55	431
Total	547.3	16 022	916	16 938	268	458	508	417	1 651	364	36	170	2	572	19 161

Table 13.9
Principal habitats in survey sectors in Map 13.3 (Peru-3)

Sector no.	Habitat description
23	Sand beach / vast sandy desert, river exit and lagoons
24	Rocky headlands, sand and gravel beaches / sand desert rising to mountains
25	Sand beaches, some low rocky shore / some low sand cliff / sandy slopes, mountains
26	Rocky sand and gravel beaches / steep sandy slopes, mountains
27	Sand beach / sandy hill slopes
28	Sand beach, occasional rock outcrops / dunes / flat sandy desert
29	Sand beaches, some gravel, sheer rocky points / sandy desert, hills
30	Sand beaches, some gravel, sheer rocky points / sandy desert, hills
31	Steep rocky coastline / cliffs / desert
32	Sand beaches, mudflats / sandy hill slopes, desert
33	Gravel and some sand beaches, some rocky sections with weed beds / sandy desert
34	River delta with sandflats, vegetated pools, gravel bars / town, farmland, desert
35	Sand beach / farmland, some ponds, desert, hills
36	Sand beach, gravel beach / eroding low sandy cliff / sandy hills, some irrigated farmland
37	Sand and gravel beaches, rocky headlands / desert slopes, mountains

other species, particularly Whimbrel (31); Willets also made their appearance, becoming regular between Pisco and Lima. Altogether, some 10 800 Sanderlings were found between Bahia de Paracas and the Chincha area (Sectors 32–35), representing 11.0% of the Pacific Coast total. Bahia de Paracas is thought to be of exceptional importance to shorebirds during migration, with reports of tens to hundreds of thousands of Sanderlings (M. Plenge, pers. commun.). During the present surveys, the highest concentrations of shorebirds were found at the mouth of the Rio Pisco, rather than in the bay at Paracas: it seems likely that the birds use the entire stretch of coast between Paracas and the Rio Pisco area as one functional unit, concentrating in those parts where food and other resources are currently most abundant.

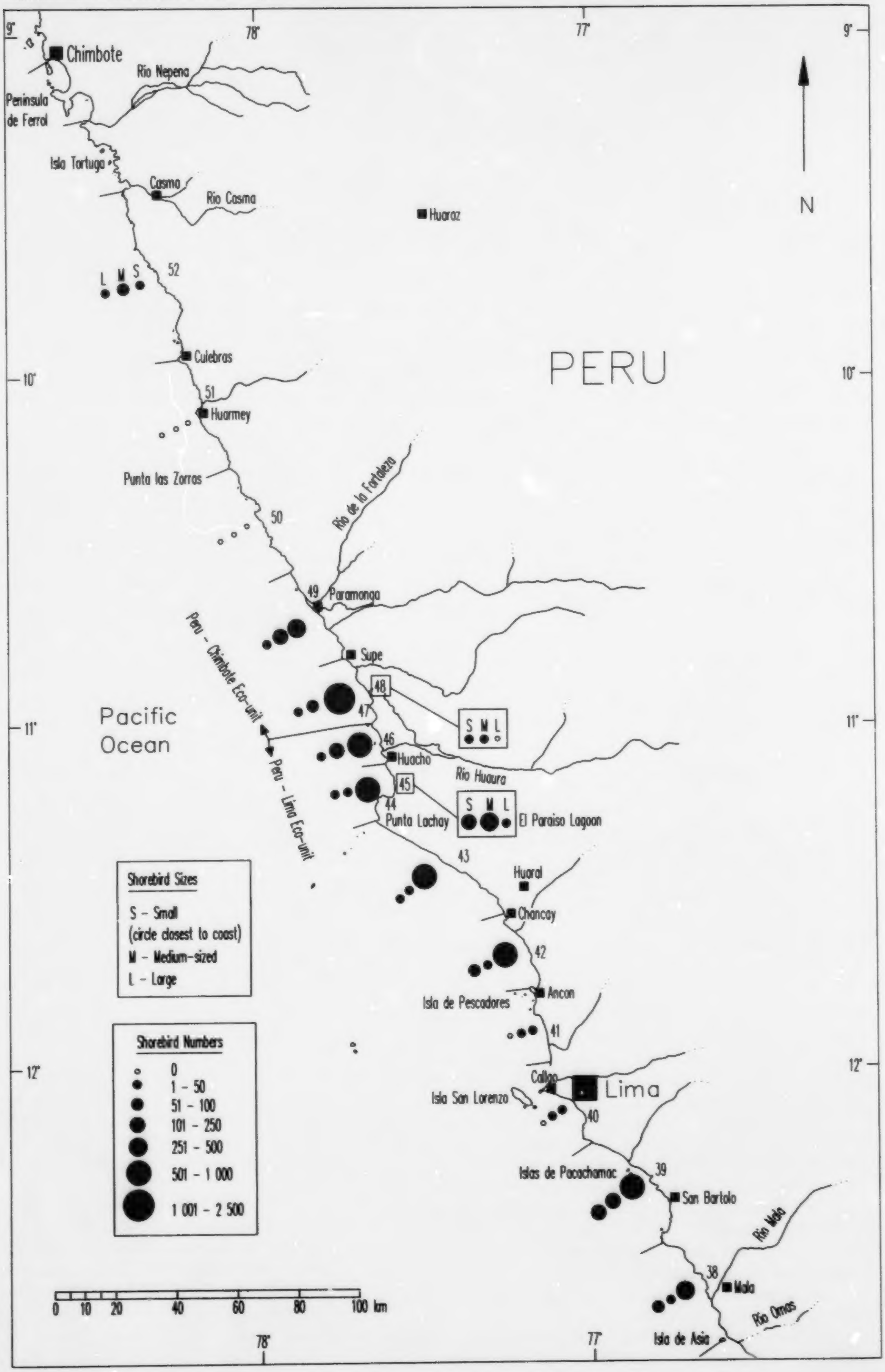
The coast between Pisco and Lima consisted of long sandy beaches, with some gravel sections, between which steep high headlands occurred. The surrounding hill slopes and hinterland were extremely arid and essentially unvegetated, apart from areas irrigated for agriculture. Various species, particularly Sanderling, were found regularly along this stretch of coast. Shorebirds appeared to be most common on the long stretches of sandy beach, such as those north of the Rio Pisco in Sector 35, those north of the Rio Canete in Sector 36, those north and south of the Isla de Asia in Sectors 37 and 38, and those south of Lima in Sector 39 (Table 13.10). Black-bellied Plovers, Ruddy Turnstones, and Whimbrels were seen all along the coast, and Willets were also regularly observed.

Few shorebirds were seen along the shoreline in the vicinity of Lima and its port of Callao (Sector 40), where the sand and gravel beaches and polluted flats were backed by the sprawling city and dockyards (Table 13.11). The steep coast with headlands and beaches north of Lima (Sector 41) also supported few shorebirds.

The series of beaches and headlands stretching northwards in Sectors 42 and 43 supported mainly Sanderlings, with smaller numbers of Ruddy Turnstones and Whimbrels. In Sector 42, the most heavily used beaches were those in the south of the sector and in the northern part near the river south of Chancay; in Sector 43, the gravel beaches north of Chancay and the long sandy ocean beach stretching towards Punta Lachay held most of the birds. Punta Lachay itself was steep and rocky; northwards in Sector 44, the beaches along the coast bordering the El Paraiso Lagoon supported substantial numbers of Sanderlings (1000). The El Paraiso Lagoon itself (Sector 45), an elongated barrier lagoon, contained an interesting variety of waterfowl and shorebirds; it was the only site supporting fairly large concentrations of peeps (240) on this section of coast.

Shorebirds continued to be common on the beaches in Sector 46, particularly north of the Rio Huaura, where the long sandy beach was backed by a number of small pools. Sanderlings were again most numerous (930), with moderate numbers of Black-bellied Plovers (90), Ruddy Turnstones (30), and Whimbrels (35) (Table 13.10).

Map 13.4 (Peru-4)
Distribution of Nearctic shorebirds along the Lima coast of Peru



9°
78°
77°
9°
Chimbote
Rio Nepena
Peninsula de Ferrol
Isla Tortuga
Casma
Rio Casma
Huaraz
N
L M S
52
Culebras
PERU
10°
10°
51
Huarmey
Punta las Zorras
Rio de la Fortaleza
50
49
Paramonga
Peru - Chimbote Eco-unit
Supe
48
S M L
Pacific Ocean
47
11°
11°
46
Huacho
Peru - Lima Eco-unit
Rio Huaura
45
44
Punta Lachay
S M L
El Paraiso Lagoon
43
Huaral
Chancay
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
42
Ancon
Isla de Pescadores
41
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
12°
12°
Callao
Lima
Isla San Lorenzo
40
Islas de Pacachamac
39
San Bartolo
Rio Mala
38
Mala
0 10 20 40 60 80 100 km
Rio Omas
Isla de Asia
78°
77°

Table 13.10
Totals of Nearctic shorebirds in survey sectors in Map 13.4 (Peru-4)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Surf-bird	Yellow-legs species	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Total shore-birds
38	39.4	0	404	0	404	2	0	0	0	0	2	63	0	0	63	469
39	51.5	0	935	5	940	61	50	0	0	13	124	44	110	0	154	1 218
40	41.6	1	21	2	24	3	25	0	0	16	44	0	0	0	0	68
41	26.2	0	11	0	11	0	3	0	0	0	3	0	0	0	0	14
42	31.6	0	567	0	567	1	11	0	0	0	12	76	5	0	81	660
43	54.0	0	983	0	983	5	2	0	0	0	7	33	0	0	33	1 023
44	25.7	0	1 000	0	1 000	1	3	0	0	0	4	4	0	0	4	1 008
45	13.0	0	0	240	240	6	5	0	60	300	371	1	0	40	41	652
46	16.2	0	930	0	930	94	30	0	0	10	134	35	5	0	40	1 104
47	28.2	0	1 090	0	1 090	76	10	0	0	0	86	25	0	0	25	1 201
48	14.9	8	0	0	8	0	0	0	30	2	32	0	0	0	0	40
49	35.5	0	269	0	269	15	124	0	0	0	139	15	0	0	15	423
50	47.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	46.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	70.5	0	40	0	40	0	55	30	0	0	85	25	0	0	25	150
Total	541.9	9	6 250	247	6 506	264	318	30	90	341	1 043	321	120	40	481	8 030

Table 13.11
Principal habitats in survey sectors in Map 13.4 (Peru-4)

Sector no.	Habitat description
38	Sand beaches, some gravel beaches, rocky headlands / cliffs / farmland, desert, mountains
39	Sand beaches, rocky headlands and cliffs / habitations, desert, mountains
40	Sand and gravel beaches, polluted flats / city, dockyards
41	Rocky headlands, sand beaches / desert, mountains
42	Sand beaches, rocky headlands / farmland, desert
43	Sand beaches, rocky headlands / sandy desert, hills
44	Sand beaches, low rocky headlands / sandy slopes, lagoon
45	Inland; lagoon behind beach, marshy shore / sandy slopes
46	Sand and gravel beaches, rocky headlands / farmland, barren sandy hills
47	Sand and gravel beaches / flat farmland, lagoon, sandy desert
48	Inland; lagoon with marshy shoreline / sandy slopes
49	Gravel beaches / wet farmlands, river exit, sandy wasteland
50	Broad sand beaches, rocky headlands / cliffs, dune fields / desert, mountains
51	Rocky shoreline / cliffs / desert, mountains
52	Sand and gravel beaches, low rocky platforms, points and headlands / rolling sandy desert, mountains

13.5.3. Chimbote eco-unit

Sectors 47–57; Maps 13.4 (Peru-4) and 13.5 (Peru-5)

The Chimbote eco-unit stretches from just north of Huacho to just south of Trujillo. Shorebird totals were very low as a result of the steep coastline and general lack of suitable habitat: some 2700 shorebirds were counted, representing 2.3% of the Peruvian total. Most of the birds were seen in the southern part of the eco-unit, between Medio Mundo and Paramonga; smaller numbers occurred between Chimbote and Trujillo, principally along the long desert ocean beach north of the Rio Santa. Very few birds were seen along the steep, arid coastline between Paramonga and Chimbote.

A series of gravel and sand beaches occurred in Sector 47, interrupted by occasional headlands (Table 13.11). A large lagoon occurred behind the gravel beaches around the northern exit of the Rio Huara (Sector 48), and sand beaches backed by agricultural land around the river mouth south of Supe. Sanderlings (1100) were numerous along the beaches, and Black-bellied Plovers (80), Ruddy Turnstones (10), and Whimbrels (25) were all observed regularly (Table 13.10). The lagoon itself (Sector 48) contained relatively few shorebirds, mostly yellowlegs (30) and a few Spotted Sandpipers *Actitis macularia* (2), the total of 40 being the lowest for the nine coastal wetlands covered during the surveys; large numbers of gulls, terns, and waterfowl, however, were found in the lagoon. In Sector 49, the Rio Pativilca has built a blunt delta; gravel beaches run along the shoreline and are backed by irrigated, agricultural land, including the sugar ranch at Paramonga. Sanderlings (270) and Ruddy Turnstones (120, the highest sector total in the eco-unit) were fairly common, with smaller numbers of Black-bellied Plovers and Whimbrels. The shorebirds observed along the beaches of Sectors 47 and 49 (total 1600) accounted for some 60.8% of the shorebirds in the eco-unit.

Very few shorebirds were found between Paramonga and Chimbote. Much of the coastline is steep or hilly: embayments have formed on Cenozoic volcanics, with shore platforms fronting cliffs and the harder elements persisting as rocky headlands. Some beaches are found in coves along the coast. No shorebirds were seen in Sector 50, although it contained much attractive scenery: beaches backed by rolling dune fields, then desert leading to a backdrop of mountains, or low rocky wave-washed shores with rocky headlands and cliffs separating the lower sections (Table 13.11). In Sector 51, the coastline was steep from south of Punta las Zorras to Huarmey. A sandy beach stretched north from Huarmey, backed at first by some pools near the river entrance, then by colourful dunes, before the coast became low and rocky. Sand and gravel beaches mixed with low rocky platforms, points, and headlands alternated with steeper stretches, this terrain continuing through Sector 52 to Casma. The scalloped cliffy coastline notched with wadis, or ephemeral stream channels, north of Huarmey (Bird and Ramos 1985) is fringed with many islands and headlands used by seabirds. The steep, mountainous coastline persisted through Sector 53, with some beaches near the Rio Nepena south of the Peninsula de Ferrol, where the 120 Sanderlings observed in the sector were found (Tables 13.12 and 13.13). Only occasional small flocks of shorebirds were seen on the outer coasts in Sectors 50–53, mostly consisting

Map 13.5 (Peru-5)
Distribution of Nearctic shorebirds along the Trujillo coast of Peru

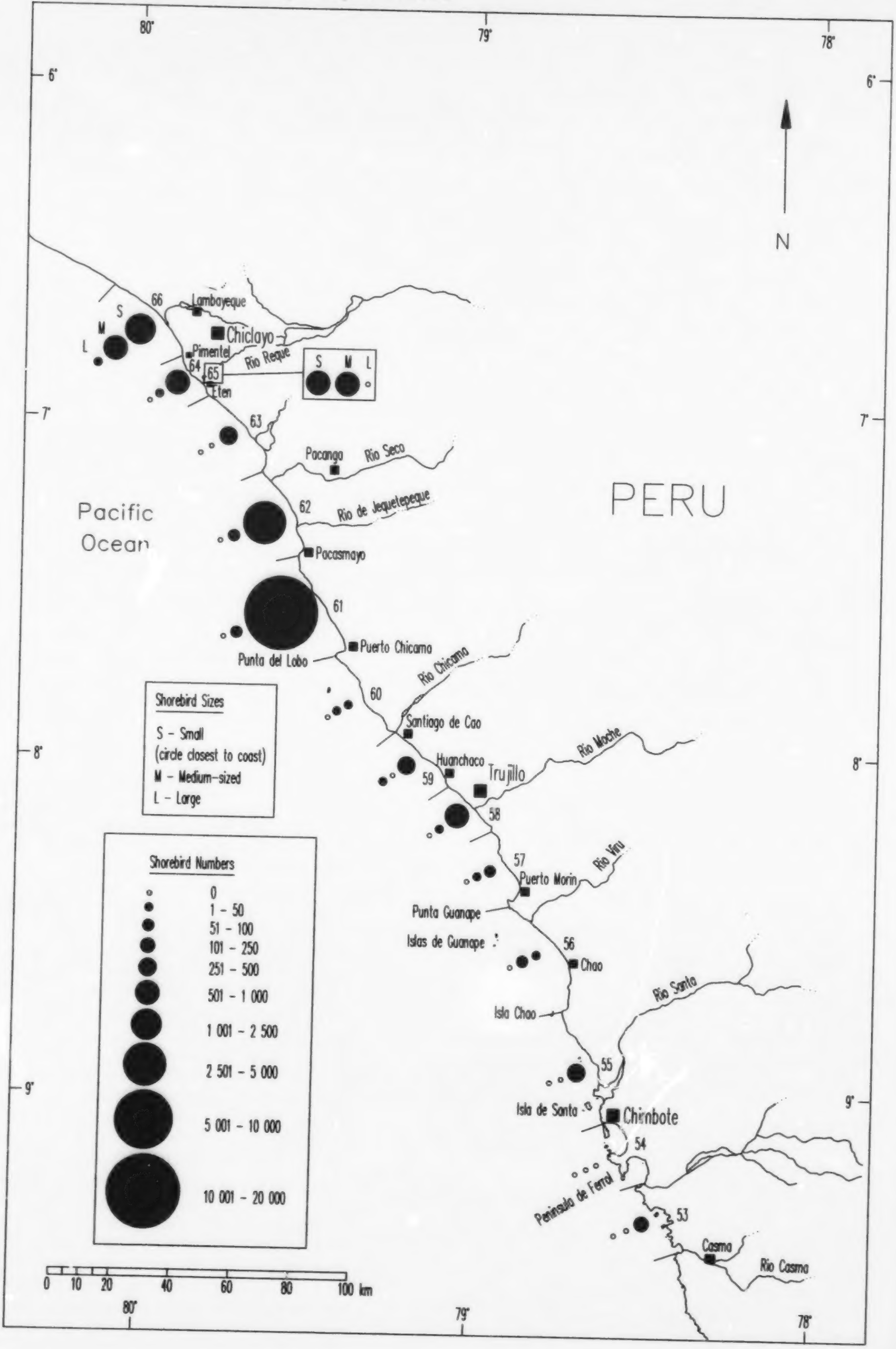

80°
79°
78°
6°
7°
8°
9°
N
PERU
Pacific Ocean
66
Lambayeque
Chiclayo
Pimentel
64
65
Eten
Rio Reque
S M L
63
Pocango
Rio Seco
62
Rio de Jequetepeque
Pacasmayo
61
Puerto Chicama
Punta del Lobo
Rio Chicama
60
Santiago de Cao
Huanchaco
Trujillo
Rio Moche
59
58
57
Puerto Morin
Rio Viru
Punta Guanape
Islas de Guanape
56
Chao
Isla Chao
Rio Santa
55
Isla de Santa
Chimbote
54
Peninsula de Ferrol
53
Casma
Rio Casma
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
0 10 20 40 60 80 100 km

Table 13.12
Totals of Nearctic shorebirds in survey sectors in Map 13.5 (Peru-5)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
53	32.3	120	0	120	0	0	0	0	0	0	0	0	120
54	27.8	0	0	0	0	0	0	0	0	0	0	0	0
55	45.9	497	0	497	0	0	0	0	0	0	0	0	497
56	46.1	50	0	50	20	70	0	0	90	0	0	0	140
57	31.3	97	0	97	3	0	0	0	3	0	0	0	100
58	20.8	620	0	620	0	15	0	0	15	0	0	0	635
59	26.8	330	0	330	0	0	0	0	0	0	33	33	363
60	33.9	25	0	25	0	1	0	3	4	0	0	0	29
61	39.9	11 098	0	11 098	0	58	0	0	58	0	0	0	11 156
62	33.1	3 235	0	3 235	0	100	0	0	100	0	0	0	3 335
63	33.2	363	0	363	0	0	0	0	0	0	0	0	363
64	10.3	575	0	575	1	0	0	0	1	0	0	0	576
65	6.2	800	20	820	41	20	453	0	514	0	0	0	1 334
66	36.6	1 089	0	1 089	4	421	0	500	925	20	0	20	2 034
Total	424.2	18 899	20	18 919	69	685	453	503	1 710	20	33	53	20 682

Table 13.13
Principal habitats in survey sectors in Map 13.5 (Peru-5)

Sector no.	Habitat description
53	Sand beaches, rocky shores and headlands / sandy desert, mountains
54	Sand beach / sandy peninsula, marshy areas
55	Sand and gravel beaches / broad sand desert, farmland, marshy ponds
56	Sand beach / broad sand desert
57	Sand beach / sand desert with some vegetated patches
58	Sand beach / river exit, barren desert
59	Sand beach, river exit / partially vegetated flat sandy desert
60	Sand and gravel beaches / partially vegetated flat sandy desert
61	Gravel and sand beaches / dunes / sand desert, occasional pool
62	Gravel and sand beaches / low gravelly cliffs / sand desert, occasional pool
63	Sand and gravel beaches, some rocky outcrops / gravelly cliffs / partially vegetated sandy hinterland
64	Sand beach / sandy desert, town
65	Inland; lagoon with wet marshy areas / sandy desert
66	Sand beach, river exit / dunes / vast sandy desert

of Sanderlings or Ruddy Turnstones; 30 Surfbirds were observed in Sector 52.

Sector 54 contained the Peninsula de Ferrol, a high hill, or tombolo, attached to the mainland by a sandy isthmus. The outer side of the peninsula is steep and rocky, although the isthmus is flat, with sandy beaches running along the north and south sides. Some wet, marshy areas occurred south of Chimbote. No shorebirds were observed in this sector.

The coastline from the Rio Santa north of Chimbote to the end of the eco-unit near Trujillo (Sectors 55–57) was very sandy, with a broad sand desert stretching inland. Striations of wind-blown sand were aligned along the direction of the prevailing southwesterly winds. Most of the birds occurred in particular stretches of the coast: along the desert coastline north of the Rio Santa in Sector 55 (500 Sanderlings), near the Rio Viru in Sector 56, and between Punta Guanape and Puerto Morin in Sector 57.

13.5.4. Chiclayo eco-unit

Sectors 58–85; Maps 13.5 (Peru-5) and 13.6 (Peru-6)

The Chiclayo eco-unit covers the northern part of the Peruvian coastline from Trujillo to the border with Ecuador and contains some of the most important shorebird habitats in Peru. The eco-unit total of 68 000 shorebirds represented 59.0% of the Peruvian total and included substantial numbers of small (52 700), medium-sized (14 200), and large (1100) shorebirds, representing 58.7, 60.8, and 49.2% of their respective Peruvian size-class totals (Table 13.1). Sanderlings were particularly numerous, with the highest concentrations of the species found in South America occurring on the beaches near Pacasmayo and along the shoreline of the Sechura Desert. More than 31 600 Sanderlings were observed in the eco-unit, representing 28.3% of the South American total and 47.3 and 32.2% of the Peruvian and Pacific Coast totals for the species, respectively (Table 13.2*a*). Small shorebirds (peeps) were also especially numerous, the eco-unit total representing the bulk (92.2%) of the peeps counted in Peru and a substantial proportion (36.0%) of those counted on the Pacific coast. By far the most important area was the Virrila estuary, which had the highest sector total (31 300) recorded in Peru, including an estimated 20 000 peeps and over 10 200 and 760 medium-sized and large species, respectively. Other particularly numerous species in the eco-unit included Ruddy Turnstones (910, 38.7% of the Pacific Coast total), yellowlegs (460, 19.2% of the Pacific Coast total), and Willets (430, 9.3% of the Pacific Coast total) (Table 13.2*b*, 13.2*c*); the total for medium-sized species made up 41.4% of the Pacific Coast total. Modest numbers of shorebirds were seen in the mangrove areas near Tumbes.

The coastal plain broadens between Trujillo and Chiclayo (Sectors 58–65), with much of the coastline consisting of sand or gravel beaches backed by a flat desert hinterland; occasional rivers reach the sea. Sand beaches formed much of the shoreline in Sectors 58 and 59 (Table 13.13). Sanderlings made up the bulk of the shorebirds seen in these sectors and were generally found near river mouths: to the north of the Rio Moche in Sector 58 and south of the Rio Chicama in Sector 59. The 33 Willets observed in Sector 59 (Table 13.12) were found north of Huanchaco in a pond near the beach in a flat vegetated

Map 13.6 (Peru-6)
Distribution of Nearctic shorebirds along the northern coast of Peru

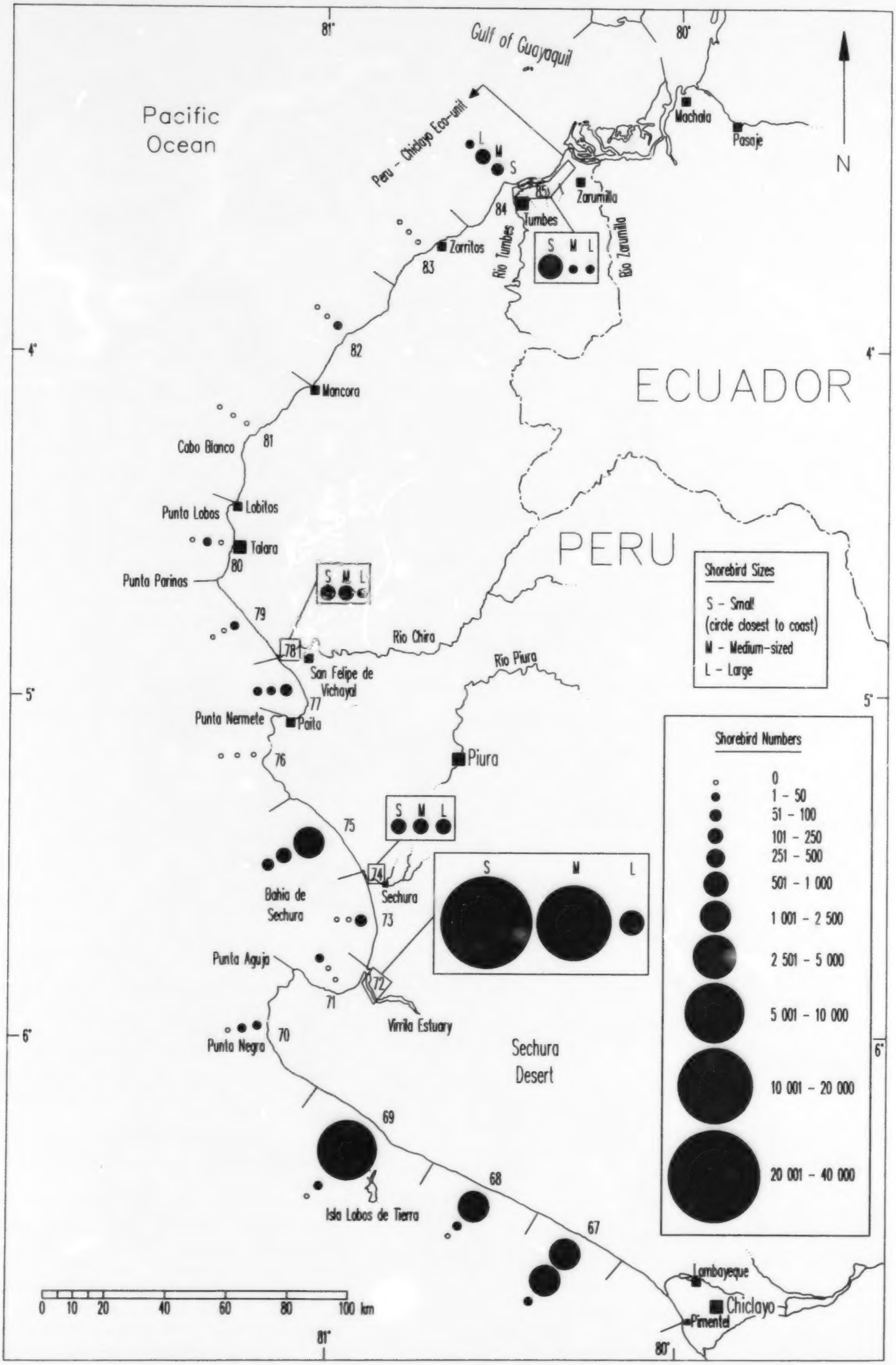

81°
80°
Gulf of Guayaquil
Pacific Ocean
Peru – Chiclayo Eco-unit
Machala
Pasaje
N
L
M
S
85
84
Tumbes
Zarumilla
Zorritos
83
S M L
Rio Tumbes
Rio Zarumilla
82
4°
Mancora
ECUADOR
81
Cabo Blanco
Punta Lobos
Lobitos
Talara
80
Punta Pariñas
S M L
PERU
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
79
78
Rio Chira
San Felipe de Vichayal
Rio Piura
5°
77
Punta Nermete
Paita
76
Piura
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
20 001 - 40 000
S M L
75
74
Sechura
S
M
L
Bahia de Sechura
73
Punta Aguja
72
71
Virrila Estuary
6°
Punta Negra
70
Sechura Desert
69
68
Isla Lobos de Tierra
67
Lambayeque
Chiclayo
Pimentel
0 10 20 40 60 80 100 km
81°
80°

Table 13.14
Totals of Nearctic shorebirds in survey sectors in Map 13.6 (Peru-6)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shore-bird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Surf-bird	Yellow-legs species	Uniden-tified medium-sized shore-bird species	Total medium-sized shore-birds	Whim-brel	Willet	Uniden-tified large shore-bird species	Total large shore-birds	Total shore-birds
67	34.8	0	1 233	0	1 233	0	140	0	0	1 490	1630	1	0	0	1	2 864
68	35.4	0	2 432	0	2 432	0	1	0	0	0	1	0	0	0	0	2 433
69	40.1	0	7 460	0	7 460	11	35	0	0	0	46	0	0	0	0	7 506
70	56.4	0	1	0	1	3	0	0	0	0	3	0	0	0	0	4
71	28.1	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2
72	23.6	0	300	20 000	20 300	0	0	0	0	10 270	10 270	55	200	500	755	31 325
73	32.4	0	55	0	55	0	0	0	0	0	0	0	0	0	0	55
74	8.9	0	0	230	230	25	0	0	1	130	156	0	170	0	170	556
75	33.9	0	1 772	0	1 772	16	120	0	0	0	136	52	0	0	52	1 960
76	37.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	29.1	1	52	0	53	1	0	2	0	0	3	3	0	0	3	59
78	12.8	0	0	200	200	60	0	0	1	90	151	0	1	0	1	352
79	31.5	0	40	0	40	0	0	0	0	0	0	0	0	0	0	40
80	29.1	0	0	0	0	5	0	0	0	0	5	0	0	0	0	5
81	50.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	43.6	0	50	0	50	0	0	0	0	0	0	0	0	0	0	50
83	32.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	43.5	17	80	0	97	5	0	0	0	150	155	28	5	0	33	285
85	27.2	5	0	572	577	31	0	0	0	0	31	8	22	0	30	638
Total	630.8	23	13 475	21 002	34 500	157	296	2	2	12 130	12 587	149	398	500	1 047	48 134

Table 13.15
Principal habitats in survey sectors in Map 13.6 (Peru-6)

Sector no.	Habitat description
67	Sand beach / dunes / vast flat sandy desert
68	Sand beach / dunes / vast flat sandy desert
69	Sand beach / dunes / vast flat sandy desert
70	Sand beach changing to rocky shore with low outcrops and points / sandy desert, hills
71	Sand beach / low clifflets / flat scrubby desert
72	Estuarine inlet, broad sandflats and sandbars / sandy desert
73	Sand beach / dunes / sandy desert
74	Inland; lagoon with narrow vegetated shoreline / sandy desert
75	Sand beach / partially vegetated dunes / sandy desert
76	Sand beaches with some rocky outcrops and headlands / cliffs / desert plateau
77	Sand beach / flat sandy desert rising to inland cliffs
78	River estuary, sandflats, partially vegetated banks / sandy desert
79	Sand beach / dunes / sandy desert
80	Sand beach / town, some cliffs, sandy desert
81	Sand beach, some rocky platforms on points / rolling rock and sand desert with scattered vegetation, steep hills
82	Sand beaches, rocky points with flat slabs, some river exits / eroded badland hills with scattered scrub
83	Sand beaches, rocky points with flat slabs, some river exits / eroded badland hills with scattered scrub
84	Sand beach, mudflats, tough mud patches / rice fields and mangrove complex, farmland, forested hills
85	Mudflats, shrimp empoundments, mangroves, rice fields / forested hills, farmland

area, behind which the sandy hills rose steeply to a plateau. Sandy beaches backed by a partially vegetated hinterland or gravel beaches backed by extensive gravel deposits occurred through Sector 60: few shorebirds were observed.

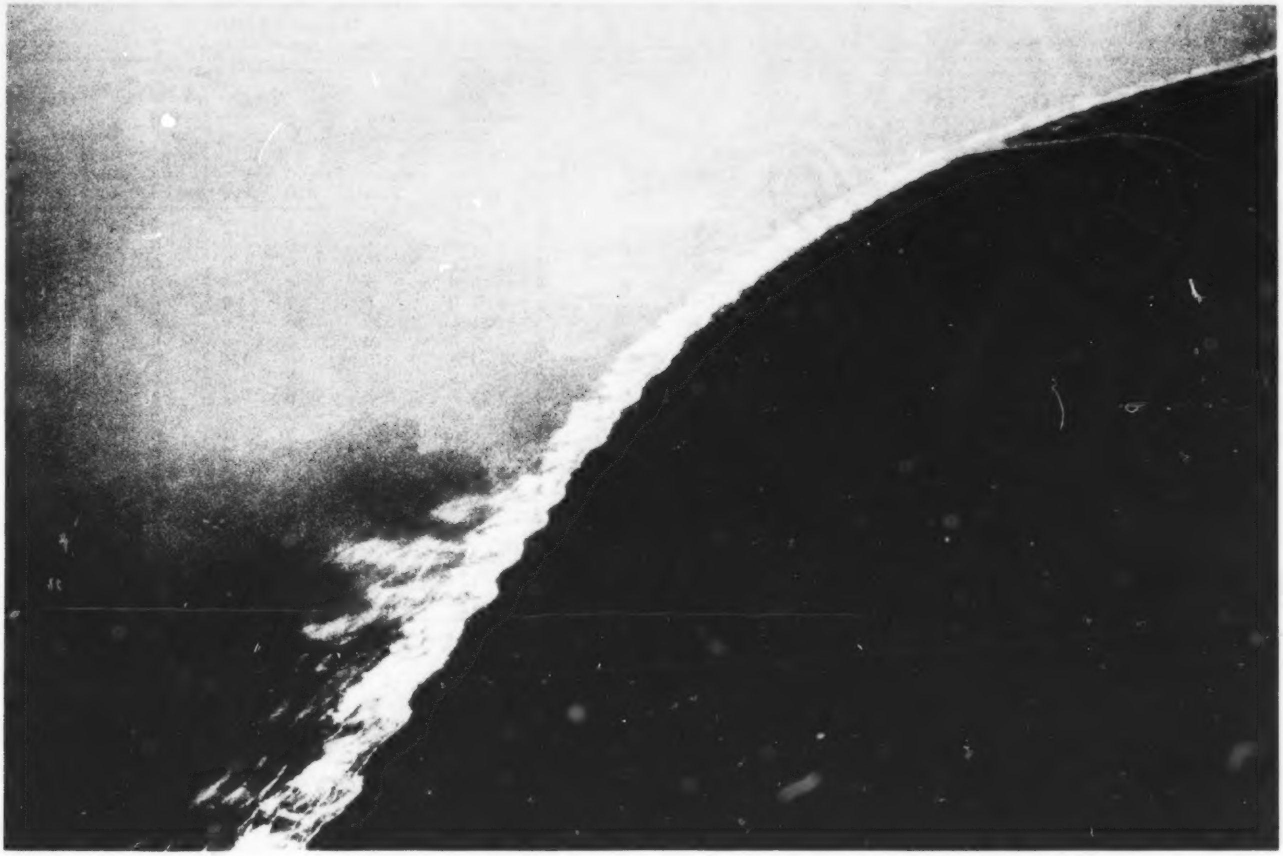
The section of coast between Puerto Chicama and Pacasmayo (Sector 61) contained the highest sector total of Sanderlings recorded on the surveys: nearly 11 100 birds were counted, representing 16.6 and 11.3% of the Peruvian and Pacific Coast totals, respectively (Table 13.12). The linear density of 280 birds per kilometre was the highest recorded for beach habitats during the surveys. The southern part of the sector contained sandy beaches backed by dunes aligned along the direction of the prevailing southwesterly wind, with a wide sandy desert inland; gravel beaches occurred in the northern part of the sector near Pacasmayo, where many of the Sanderlings were found. Some pools and vegetated areas occurred behind the beach.

Similar habitats in Sector 62 also supported large numbers of Sanderlings (3300), concentrations occurring in the vicinity of the Rio Jequetepeque and Rio Seco. Ruddy Turnstones were noted along the beaches in Sectors 61 and 62 (60 and 100, respectively).

Moderate numbers of Sanderlings were found in Sector 63 (360) and Sector 64 (580). Sand and gravel beaches continued, backed mostly by desert but occasionally by gravelly cliffs. The Sanderlings were again often observed on beaches near river courses.

Sector 65 comprised the marshy lagoons at the mouth of the Rio Reque north of Eten and contained nearly all the yellowlegs found in the eco-unit (453 of 455, representing 19.1% of the Pacific Coast total), as well as some 800 Sanderlings and smaller numbers of Black-bellied Plovers (41) and Ruddy Turnstones (20). Large numbers of gulls also occurred in the lagoons.

North of Pimentel, the most spectacular ocean beach in Peru runs along the coast for some 150 km (Sectors 66–69), forming the shoreline of the vast Sechura Desert (Table 13.15). North of the Rio Lambayeque, the beach is essentially continuous, being backed by dunes leading to the flat, arid desert behind. Huge crescent-shaped barchan dunes litter the desert floor; under the intense evaporation, rivers such as the Rio Cascaja simply fade away (Bird and Ramos 1985). Large numbers of Sanderlings were found all along the beach, particularly in Sector 69, with a total of some 12 200 in Sectors 66–69 (Tables 13.12 and 13.14). Densities ranged from about 30 to 190 birds per kilometre. These beaches, with some 12.4% of the Pacific Coast total of Sanderlings, form one of the most important wintering areas identified for the species. Substantial numbers of Ruddy Turnstones (420) were seen in Sector 66, particularly near the mouth of the



Mejia Lagoons and Rio Tambo, Peru. The long ocean beaches of Peru and Chile form the most important wintering areas for Sanderlings in South America. Wetlands may occur where rivers reach the sea, as at the Mejia Lagoons at the exit of the Rio Tambo in southern Peru; such areas are of considerable significance to migratory shorebirds, as they represent isolated patches of habitat separated by long stretches of arid coastline.

Rio Lambayeque, as well as in Sector 67 (140); large numbers of unidentified medium-sized shorebirds were seen in both sectors (500 and 1500, respectively).

The flat desert topography ended at Sector 70, where an outlying range of coastal mountains formed a hilly peninsula dissected by wadis. The shoreline between Punta Negra and Punta Aguja (Sector 70) became progressively rockier, with some sand beaches, and supported very few shorebirds.

The coast of the southern part of the Bahia de Sechura east of Punta Aguja consisted mostly of low clifflets, with sandy beach returning towards the Virrila estuary; few shorebirds were seen in this sector (Sector 71).

The Virrila estuary (Sector 72) is one of the most important wintering areas for shorebirds in Peru. An estimated 31 300 shorebirds were counted in the estuary, representing 27.2 and 14.3% of the Peruvian and Pacific Coast totals, respectively (Table 13.14), identifying the area as being of national and international importance. The overall total included significant numbers of shorebirds in the small, medium-sized, and large categories: 20 000 peeps (87.7 and 34.2% of the Peruvian and Pacific Coast totals, respectively), 10 300 medium-sized shorebirds (44.0 and 29.9% of the Peruvian and Pacific Coast totals, respectively), and 760 large shorebirds (33.8% of the Peruvian size-class total). The area consisted of a broad estuarine inlet with extensive sandflats and sandbars and supported, in addition to the shorebirds, large numbers of gulls and terns, as well as over 2700 flamingos.

Sectors 73 and 75 comprised the western shoreline of the Sechura Desert and consisted principally of sand beaches backed by dunes and desert. Relatively few Sanderlings (55) were seen between the Virrila estuary and the mouth of the Rio Piura (Sector 73), although substantial numbers (1800) occurred along the northern section of the Bahia de Sechura (Sector 75). The wetlands at the mouth of the Rio Piura (Sector 74) contained moderate numbers of shorebirds (560), which included 230 peeps and 170 Willets (Table 13.14); substantial numbers of gulls, cormorants, and pelicans were found in the wetlands.

Sandy beaches backed mostly by stratified cliffs formed the shoreline leading around the hilly peninsula of Mesozoic rock towards Paita. No Nearctic shorebirds were seen in this sector (Sector 76).

Cliffs behind the shore at Paita diverge inland not far north of the town, and a long, straight beach runs for some 50 km to Punta Parinas, broken only by the mouth of the Rio Chira. Behind the beach there is a flat sandy plain, which is inundated by high tides and covered with evaporite deposits (Bird and Ramos 1985). Relatively few shorebirds were seen along the beach south (Sector 77) and north (Sector 79) of the river mouth, and most were Sanderlings (52 and 40, respectively).

The wetlands at the mouth of the Rio Chira (Sector 78) contained moderate numbers of shorebirds (350), including 200 peeps and smaller numbers of Black-bellied Plovers, yellowlegs, and Willets.

Very few shorebirds were observed on the coastline between Punta Parinas and Zorritos. Oil platforms were numerous offshore, and oil pumping stations were evident in many places along the coast. An early Holocene coastline marked by gullied bluffs behind intervening sectors of coastal plain (Bird and Ramos 1985) is found north of Punta Parinas, resulting in a sandy or rocky shore backed by hills or cliffs in Sector 80. The coastline towards Zorritos is fairly steep; it is cut into a fringe of uplifted Tertiary formations that dip gently seaward and are capped by a series of Quaternary marine terraces incised by transverse valleys. The result is a shoreline made up of sandy stretches mixed with rocky points and slabs, with a number of river valleys blocked by sand, behind which is found a rolling rock or sand desert and badlands with scattered scrub.

Towards the border with Ecuador, the large sandy Tumbes delta forms the extreme southern shore of the Gulf of Guayaquil. The outer shoreline of this area (Sector 84) consists of sandy beaches, with some mudflats and tough mud patches, backed by rice fields, farmland, and mangrove complexes (Table 13.15). Some Sanderlings (80) and Whimbrels (28) were seen along the sandy outer shore, although numbers of shorebirds were generally low. The Tumbes area marks the southern limit of mangroves on the Pacific coast. Behind the shoreline lie fairly extensive mangrove complexes, with associated channels and mudflats (Sector 85). Moderate numbers of peeps (570) were found on the mudflats, with smaller numbers of Black-bellied Plovers (31), Willets (22), and Whimbrels (8). Large areas were being cleared for the construction of shrimp-farming ponds, involving considerable loss of mangrove habitat.

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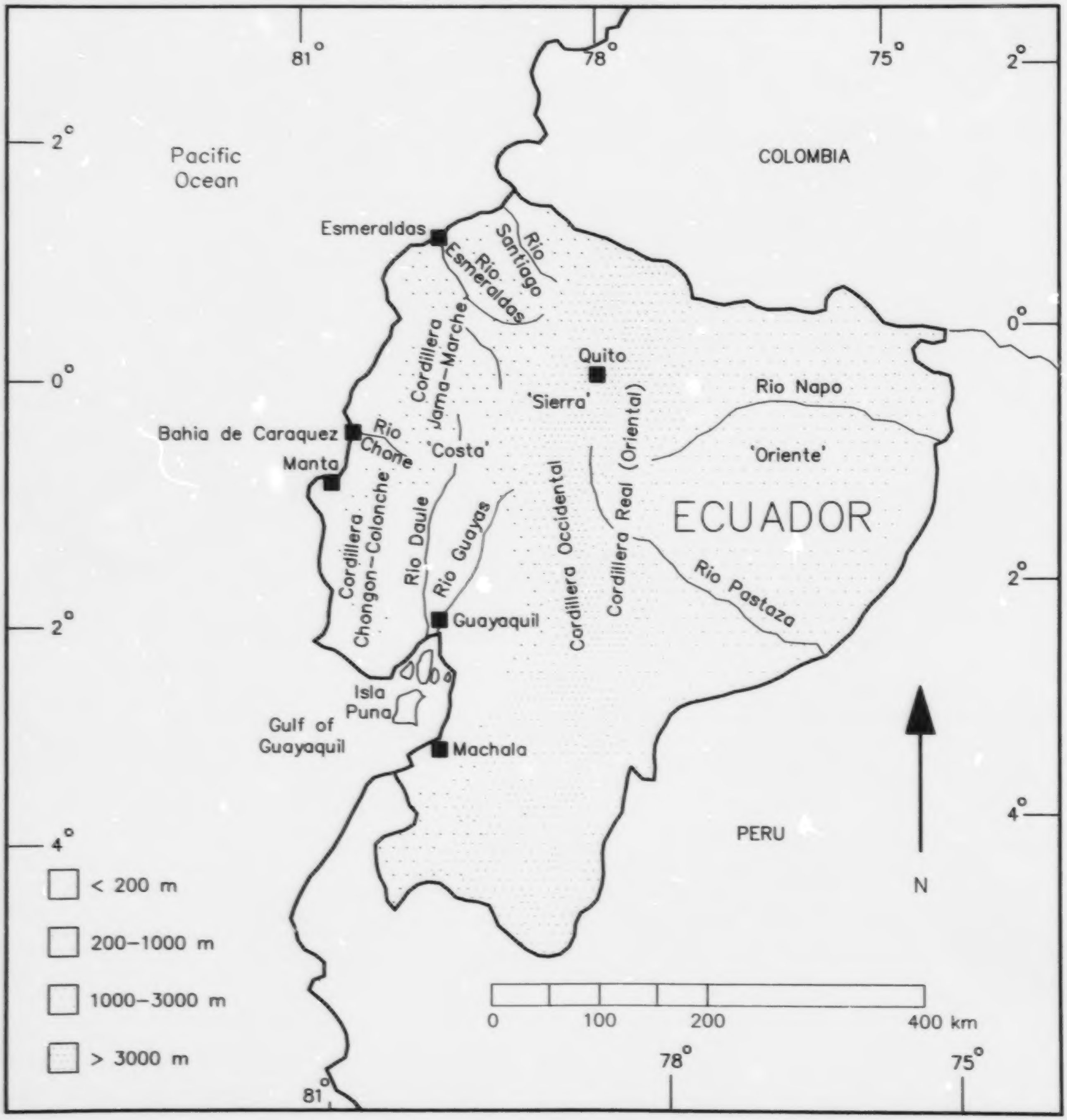
Figure 14.1
Some of the main geographical features of Ecuador


81°
78°
75°
2°
2°
0°
0°
2°
2°
4°
4°
Pacific Ocean
COLOMBIA
Esmeraldas
Rio Santiago
Rio Esmeraldas
Cordillera Jama-Marche
Quito
'Sierra'
Rio Napo
Bahia de Caraquez
Rio Chone
'Costa'
Manta
'Oriente'
Cordillera Chongon-Colonche
Rio Daule
Rio Guayas
Cordillera Occidental
Cordillera Real (Oriental)
ECUADOR
Rio Pastaza
Guayaquil
Isla Puna
Gulf of Guayaquil
Machala
PERU
N
< 200 m
200–1000 m
1000–3000 m
> 3000 m
0
100
200
400 km
78°
75°
81°

Chapter 14

Ecuador

R.I.G. Morrison, R.K. Ross, C. Downes, N. Hilgert de Benavides, and F. Man Ging

14.1. General geography

The Republic of Ecuador lies across the equator on the Pacific coast of South America, extending from 1°20′N at the border with Colombia to 5°S at the border with Peru (Fig. 14.1). It has a surface area of approximately 270 000 km^2 (Ortiz 1986) and a coastline of about 2500 km (Ayon and Jara 1985), including the shores of the offshore islands and the Galapagos Islands, nearly 1000 km west in the Pacific Ocean.

There are three distinct physiographic regions in Ecuador that run north–northeast, parallel with the Andes: the Costa, the Sierra, and the Oriente (Oppenheim 1950; Kehrer and van der Kaaden 1980; Kennerley 1980).

The Costa comprises the area between the Pacific Ocean and the Andes. It consists of the broad Guayas Basin in the north and the narrow coastal plain south of Guayaquil (Kennerley 1980). The Pacific Coast Range lies along the coast, extending from Colombia across the coast of northern Ecuador, and is separate from the Andes. Its hills rise to 600 m and include the Cordillera Chongon–Colonche and the Cordillera Jama–Marche. The Gulf of Guayaquil, formed by the interaction of two faults on the south coast near Peru, is the only major indentation on the coast of Ecuador—and along the entire west coast of South America (Campbell 1975), until the Gulf of Ancud, Chile, and the fjords of Magellanes.

The Sierra comprises the southern part of the northern Andes fold belt, which runs from Colombia and Venezuela through Ecuador (Campbell 1975). The Ecuadorian section is 120 km wide, representing the narrowest part of the entire Andean range along the western margin of South America. In this region, the Andes are made up of two parallel ranges, the Cordillera Occidental and the Cordillera Real, which are separated by the Inter-Andean Depression. South of 2°S, the divisions of the Sierra become less well defined (Kehrer and van der Kaaden 1980).

The third region, the Oriente, extends inland from the eastern foothills of the Andes to the Amazon Basin. Running parallel to the Andes on the eastern margin are the low ranges of the Napo Uplift in the north and the Cordillera Cutucu in the south; these structures are analogous to the Cordillera Oriental of Colombia and Peru (Kennerley 1980).

The coast of Ecuador consists of a narrow coastal plain between the western Andes and the Pacific Ocean; it is broken in some places by mountain spurs and hills and intersected by a number of small streams. The coastal plain is about 50 km wide in the north, broadening to 200 km at Punta Santa Elena and narrowing again to about 30 km towards the Peruvian border (Ferndon 1950). Sudden changes in climate and aspect between areas only a few kilometres apart are an outstanding feature of the coast. The northern coast is densely vegetated; in the extreme south, there is almost no vegetation. In the Bahia de Atacames (1°N), thick forests and abundant rains occur; at Manta (1°S), a desert climate is found. At Salango, the coast has a moist atmosphere and is well vegetated; at Santa Elena (2°S), conditions are arid with a scanty vegetation cover. In the southern regions, the Gulf of Guayaquil is covered with mangrove swamps and impenetrable thickets (US Naval Hydrographic Office 1968; Scott and Carbonell 1986).

Ecuador can be divided into two major geological provinces, separated by the Guayaquil and Dolores fault systems running from the Gulf of Guayaquil past Quito to the northern border with Colombia at about 78°W (Campbell 1975). The eastern province is underlain by Precambrian rocks belonging to the Guyana Shield overlain by Phanerozoic sediments, whereas the western province appears to have a basement of Mesozoic rocks capped by a thin Tertiary succession.

14.2. Coastal geomorphology

Much of the coastline of Ecuador consists of rocky promontories, cliffs, and pocket beaches alternating with sandy shorelines and areas of mangrove forest. The estuaries and inlets of the northern part of the Ecuadorian coast are fringed by mangrove swamps, and the Gulf of Guayaquil contains enormous areas of mangroves in its inner reaches, many of which have been modified for shrimp culture (Scott and Carbonell 1986).

In the north, the Ancon de Sardinas Bay near the Colombian border consists of flat areas of mangroves and salt marshes. The Rio Santiago basin drains the waters of the region northwestward to the Pacific Ocean. The central and lower parts of the basin are characterized by low hills and flat floodplains. To the south, high hills separate the Santiago and Esmeraldas drainage basins (Ferndon 1950). To the north, a region of deltaic swampland, covered by mangrove jungle and cut by tidal channels and finger-like bays, extends from the Santiago basin to Buenaventura in Colombia. Occasionally, silt has been deposited to form a low bank (Ferndon 1950). Between Punta Ostiones and Muisne, cliffs and shore platforms occur, with sandy beaches close to the base of the rocky cliffs (Ayon and Jara 1985).

From La Tola to Bolivar, at the mouth of the Cojimes estuary, the coastal fringe consists of hills interrupted by narrow, flat-floored river valleys. The Rio Esmeraldas drains an area of over 250 km^2 (Carlson 1952) and has a wide mouth, with an estuary bordered by mudflats on the northeastern side of the river (Ayon and Jara 1985). Cliffs and cliff-edged promontories have developed where the ocean meets the hills. Between La Tola and Vainilla, there is a small stretch of delta plain. At Muisne and Bolivar, two small channelled estuarine lowlands occur (Ferndon 1950).

The Cojimies Peninsula, just north of the equator, acts as a barrier, enclosing a bay with sandbars developing at its mouth. Mangroves and salt marshes occur along the border of the bay and northwards along the coast. Apart from the sandy plain south of Cojimies, the country from Punta Pedernales to Bahia de Caraquez is hilly and dissected by small rivers with narrow floodplains similar to the Esmeraldas coastal plain (Ferndon 1950).

The Bahia de Caraquez marks the climatic division between the moist northern region and the tropical savannah zone to the south. Erosion has occurred on the southern part of the beach at Bahia de Caraquez, whereas accretion has occurred on the north side (Bird 1985). Mangrove barriers and sandy spits border a lagoon at the mouth of the Rio Chone emptying into the bay (Ayon and Jara 1985).

Beaches interrupted by rocky headlands occur in the drier regions south of Bahia de Caraquez. Beaches and dunes are found along the broad, open Bahia de Jaramijo. The Rio Charapoto enters the northern half of the bay through a delta, which extends as a plain along the coast. Drifting sand has occurred north and south of the harbour at Manta, and the cliffs have receded. Beach recession has also occurred farther south near Salinas, where beachrock has been exposed along the steep beach (Ayon and Jara 1985; Bird 1985). The land along the coast from Manta south to Ayangue is intersected by drainage channels eroded into Tertiary sandstones and conglomerates. Many of these channels, e.g., at the Rio Seco, form deep gorges in the rocks (Sheppard 1930). Pocket beaches alternating with rocky bluffs are found along the coast near Ayanque, bordered by offshore, cliffed islands. Isla la Plata, which lies about 27 km off the coast south of Cabo San Lorenzo (1°16′S), has a volcanic rock base overlain by Quaternary tablazos or marine beach levels. The northern and eastern sides of the island are steep, whereas the western side slopes towards the Pacific Ocean. Isla la Plata is well known for its ocean birds (Murphy 1936).

The Gulf of Guayaquil forms an area of transition between the humid coasts of Colombia and northern Ecuador and the coastal deserts of Peru and Chile (Smith *et al.* 1971). It is a large inlet about 200 km wide at the entrance between Punta Santa Elena in Ecuador and Cabo Blanco in Peru. The Gulf of Guayaquil has been described by Murphy (1936) as a "relic of an ancient larger estuary, bordered by islands of silt consolidated by mangroves and penetrated by creeks . . . ." It is a triangular-shaped area separated at its mouth by the large Isla Puna. In the background lies a range of rounded hills. Punta Santa Elena, at the northern border of the gulf (2°11′S), is a narrow promontory projecting about 6 km from the coastline. The promontory is bare and sandy and rises to a steep, flat-topped hill at its northern end, which represents a marine terrace of Pleistocene age (Marchant 1958). It is joined to the mainland by a sandy isthmus. At Punta Santa Elena, the coastline bends southeastwards, and a series of marine terraces occurs. The larger streams have cut into the surface to form valleys. In the larger watersheds, especially in areas of Pleistocene terraces, the country is quite flat (Marchant 1961). The northeastern border, between Salinas and Posoja, is a fairly straight line of alternating cliffs and low-lying plains, with some coastal dunes (Ayon and Jara 1985). Between Santa Elena and Ancon, the coast is mainly sandy, except where rocky ledges occur. Behind it are low cliffs or dunes. Southeast of Ancon, the coast consists of high cliffs up to 45 m and shows a rain-dissected terrain with many small drainage channels, giving the area a badlands topography. This dissection occurs in areas where the hard, calcareous Quaternary rock has been removed by erosion and the soft, easily carved Tertiary shales are exposed. Drainage channels have formed in years of high rainfall and have become more deeply emphasized by tectonic uplift of the coastal area during the Quaternary (Sheppard 1930). The south coast of Punta Santa Elena is constantly exposed to the strong surf, in contrast to the low, sheltered north coast of the peninsula, along which are found sandy beaches, alternating occasionally with hillsides. The quiet north coast provides preferred habitat for shorebirds (Marchant 1958), including many species of North American migrants.

The Rio Guayas, emptying into the Gulf of Guayaquil, is the largest river on the western coast of South America, having a drainage basin of more than 36 250 km^2 (Carlson 1952). The lower part of the river contains many mangrove islands, from which large mudbanks extend (US Naval Hydrographic Office 1968). At the mouth of the Rio Guayas, the estuary is surrounded by plains of mud and silt removed from the cordillera by streams. Finer sediments are added to the estuary during the rainy season. Deposition of sand and silt from the river is enlarging the deltaic islands, promoting the advance of mangroves, and building up shoals south of Guayaquil (Bird 1985). Around the shores of the gulf there are successive zones of mangrove swamps, supported by mud deposited during the rainy season, savannahs, and agricultural land (Sheppard 1946). The Rio Guayas has built an area of some 640 km^2 of mangrove-fringed salt marshes (Ayon and Jara 1985). In recent years, extensive areas have been cleared on the islands and shorelines of the estuary for the construction of ponds for shrimp farming (Scott and Carbonell 1986).

The southeastern shore of the Gulf of Guayaquil towards the Jambeli Archipelago forms an extensive fluvial plain fed by the Rio Guayas. Shorelines along the broad, shallow Canal de Jambeli are exposed to strong tidal currents. At low tide, small deltas appear at the river mouths. Isla Puna shelters the inner estuary and is fringed by sandbars and mudflats. The eastern coast of the island consists mainly of mangrove swamps intersected by creeks. The northern coast consists of cliffs with a narrow beach at their foot, with extensive flats along some sections. At the southern end of Isla Puna, there is a low ridge of hills, the western part of which forms a long tableland (US Naval Hydrographic Office 1968). The west coast is generally sandy, with a narrow intertidal zone.

14.3. Climate

A number of features combine to give Ecuador a variable climate. These factors include its position on the equator, resulting in the country being subjected to both northeasterly and southeasterly trade winds, and the ocean currents flowing along its coast, which combine to vary the amount and seasonal distribution of rainfall. The Andean range forms the backbone of the country, resulting in altitudinal zones of climate.

Two ocean currents occur along the south and central west coast. The cool Peru (Humboldt) Current flows northwards along the southern coast, causing the same desert conditions as in northern Peru. However, the warm southward-flowing El Nino Current, accompanied by rain, dominates the entire coast from December to April. These two currents combine to produce a series of wet and dry climates along the central and southern coasts.

The major factors determining temperatures in Ecuador are its position on the equator and altitude, which ranges from sea level to 6000 m. The coastal plain of Ecuador is hot and humid year-round, with little seasonal variation, except in the extreme southwest, where it is somewhat cooler. The highest average annual temperatures, 25–26°C, occur in the Guayaquil area on the west coast lowlands at altitudes of 5–30 m. There is a wide diurnal fluctuation in temperature, but a relatively small seasonal one. The average daily temperature along the coast ranges from a daytime high of 30°C to a nighttime low of 20°C, whereas the seasonal temperature fluctuation at 1°S is only about 2°C. Winds tend to be light and variable, with stronger winds on the coast. In May and June, southeasterly trade winds are dominant; they are replaced by northerly winds during the rainy season (Johnson 1976).

Rainfall varies widely along the coast of Ecuador, from the dense tropical rain forests of Esmeraldas in the north and the Rio Guayas Basin in the south to the dry areas of Punta Santa Elena in the south. The northern coast is very wet throughout the year, and there is no dry season. South of Esmeraldas, a dry season occurs between May and December. At Manta, less than 1° from the equator, the west coast desert begins to appear. The area receives an average annual rainfall of 172 mm (Johnson 1976), mainly between January and April. Inland from Manta, the rainfall rapidly increases; at Portoviejo, 30 km inland, rainfall is almost double that on the coast.

Southwest Ecuador, lying at right angles to the prevailing southwesterly winds, forms a transition zone between the wet tropical climate to the north and the arid desert coast, which is under the influence of the Peru (Humboldt) Current, to the south. The transition zone lies along a line extending from south of the equator at Cabo Pasado to the Gulf of Guayaquil and into the Tumbes area of Peru, east of which rain falls throughout the year and west of which rain occurs only at intervals (Svenson 1946). The Gulf of Guayaquil lies within the rainfall zone, perhaps as a result of the warm waters of the gulf causing increased evaporation and hence increased precipitation on the north and east sides of the gulf. The coastal desert of Peru and Chile does not, in fact, end abruptly at the Gulf of Guayaquil, where tropical rain appears, because the coastal strip of desert reappears after the coast turns west towards the Pacific (Johnson 1976). The Santa Elena peninsula is the driest area in the country, receiving 56 mm of rain at Salinas. Guayaquil is located on the edge of the semiarid area to the west and the mangrove swamps of the Guayas Valley to the north. Machala, on the southern coast of the Gulf of Guayaquil, receives about 50 cm of rain, 78% of which falls between January and April (Rumney 1968).

14.4. Vegetation

The wet tropical rain forests of Colombia continue along the north coast of Ecuador to Esmeraldas. To the south, the rain forest gradually changes to arid vegetation, and an arid zone extends inland about 40 km in the southern areas of Ecuador (Svenson 1945).

The tropical rain forest, or "rainbelt" (Johnson 1976), continues in an unbroken line between the Andean foothills and the coast, stretching southward from the Gulf of Panama to the equator. South of the equator, it exists only in isolated patches along the coast, the southernmost of which is at Manglaralto (1°49′S) (Svenson 1946). From there, the rain forest curves eastward and is gradually replaced by a narrow, interior belt of semideciduous trees. Along the coast, between the semideciduous belt and the sea, savannah woodland becomes dominant and continues south to Peru. Drier scrub woodland appears at intervals and yields to arid desert around Punta Santa Elena (Rumney 1968).

Punta Santa Elena currently lacks mangrove vegetation, although faunal distributions indicate that some mangroves were present in the past in this area. Some areas of the Santa Elena peninsula are completely bare, whereas others have a mixed vegetation ranging from grasses and annuals, which appear only after rain, to thickets of shrubs along the drainage channels and, in favourable areas, open woodlands or trees and arboreal cacti. On Pleistocene terraces, grassland or dry plain often occurs (Marchant 1958). The hills of the Colonche and Pajan have tropical vegetation, supported year-round by the oceanic fogs of the Peruvian current (Sarma 1974).

During rainy periods, the sandy southwestern area is covered by low grasses, giving way inland to savannahs of *Pennisetum* spp., *Ipomoea pescaprae*, *I. kinbergi*, *Pectic* spp., and isolated stunted shrubs of *Maytenus* and *Acacia*. On both sides of the Gulf of Guayaquil, sparse groves of *Loxopterygium huasango* appear on the low ridges near the coast (Svenson 1945).

During the rainy season, floating islands of aquatic vegetation occur in the Gulf of Guayaquil. These are dislodged by the floodwaters of the Rio Guayas and are eventually broken down by tidal currents (Sheppard 1937). Occasionally during the rains, the volume of fresh water entering the gulf from the many rivers draining Ecuador and Peru causes a drop in salinity of the coastal waters. This factor, combined with the effects of the El Nino Current, may disrupt the fish life of the area and in turn cause starvation in bird populations (Sheppard 1937).

Mangrove vegetation is found mainly in two areas along the Pacific coast of Ecuador. The first stretches from La Tola in Esmeraldas province north to Colombia (Sarma 1974), an area marked by maximum heat and rainfall. The second occurs around the Gulf of Guayaquil and continues south to Tumbes in Peru. Isla Puna and other islands of the gulf are covered with mangrove swamps. Vegetation-free areas within the coastal mangroves of Isla Puna and around the Gulf of Guayaquil may result from the development of hypersaline conditions (Fosberg 1961; West 1977). The coast between the Mira and Santiago rivers is fringed with mangroves, although their distribution is uneven along the coast between the Rio Vainilla and the Rio Santiago.

14.5. Shorebird distribution

Numbers of shorebirds observed during surveys in Ecuador in February 1986 were generally very modest, the total of 9800 representing only 4.5% of the regional total for the Pacific Coast and 0.3% of the total for South America. The total was made up of 2300 small shorebirds (23.3%), 3500 medium-sized shorebirds (35.7%), and 4000 large shorebirds (41.0%); Ecuador was the only country in which large shorebirds formed the highest proportion of the total, and in only a relatively small number of countries did the total for the medium-sized species exceed that for small ones (Table 14.1).

Although the total number of peeps was small (2000), representing 3.5% of the Pacific Coast total (Table 14.2*a*), Ecuador supported highly significant proportions of the totals for several medium-sized and large species of shorebirds on the Pacific coast (Table 14.2*b*, 14.2*c*). These included the Black-bellied Plover *Pluvialis squatarola*, dowitchers *Limnodromus* spp., and Willet *Catoptrophorus semipalmatus*, for which the totals of 1100, 830, and 3400 represented 37.7, 57.7, and 72.7% of the Pacific Coast regional totals, respectively (Table 14.2*b*, 14.2*c*).

The majority of shorebirds were found on the mangrove coastlines around the inner parts of the Gulf of Guayaquil. The mainland coasts in this area (Sectors 1-8; see Map 14.1) supported 5100 shorebirds, or 52.4% of the Ecuadorian total, with a further 700, or 7.2%, on the Isla Puna. The next most important area identified on the surveys was the Bahia de Caraquez (Sector 30; see Map 14.2), which supported 2400 shorebirds, or 24.7% of the Ecuadorian total. Smaller numbers were found around the Cojimies/Muisne area (Sectors 36 and 37, 820, 8.4%) and on the outer shoreline and mangroves on the north coast between Rioverde and the border with Colombia in Sectors 43-45 (430, 4.4%).

The low numbers of small shorebirds found around the Gulf of Guayaquil was surprising, given the extensive areas of intertidal mudflats that occur in the region. It may be noted that similar mangrove estuaries in tropical regions of the east coast of Brazil near Salvador also supported only small numbers of peeps, despite the presence of apparently suitable-looking habitat. Given the presence of significant numbers of medium-sized and large shorebirds in the Gulf of Guayaquil, the question arises whether the available food resources are suitable for the smaller species of shorebirds.

Ground observations indicate that much larger concentrations of shorebirds are present during migration periods in the Gulf of Guayaquil, and it seems likely that the area may be of considerable importance at such times of the year; further work is required to assess the importance of this and other areas during migration periods.

14.5.1. Southern Ecuador

Sectors 1-28; Map 14.1 (Ecuador-1)

Sectors 1-4 formed the eastern shore of the Gulf of Guayaquil and Canal de Jambeli and contained the largest numbers of shorebirds recorded on the surveys in Ecuador (Table 14.3). The shoreline of the Jambeli Archipelago (Sector 1) was relatively sandy, with a mixture of sandflats and mudflats along the coast, backed by mangroves (Table 14.4). Sandy beaches along the outer coast of the islands are prograding northwards. The archipelago covers an area of some 260 km^2 and has undergone continental uplifting during Holocene times.

Large areas of intertidal flats occurred throughout Sectors 2, 3, and 4, and sediments became progressively finer towards the inner part of the estuary, with very soft, silty-looking flats being observed in Sector 4. Extensive construction of shrimp ponds has taken place throughout the estuary, involving the removal of large areas of mangroves along practically every part of the shore. Moderate numbers of peeps were seen along the flats, with Black-bellied Plovers, yellowlegs *Tringa* spp., Whimbrels *Numenius phaeopus*, and Willets making up the bulk of other species: maximum numbers occurred in Sector 3 (Table 14.3), opposite the northern part of the Isla Puna, north of Balde. Mudflats were most extensively developed on the east side of the channel in Sector 4, with either very narrow or no flats along the western side of the channel in Sector 5, in which no shorebirds were found. The shorelines of the channels are subjected to strong currents under the influence of the tides, which reach 4.5 m in range.

Extensive mudflats occurred off the southern shores of the islands forming the inner part of the estuary in Sector 6; few small shorebirds occurred on these habitats, although moderate numbers of Willets (360) were observed, along with a few Black-bellied Plovers (50). On the west side of the estuary, mudflats were again better developed on the east side of the main channel in Sector 7; again, few shorebirds were seen, mostly small numbers of peeps (180) and Willets (160). The same species were found in smaller numbers along the west shore of the estuary in Sector 8, where the flats were mostly fairly narrow, becoming tougher and then sandier towards the mouth of the estuary at Punta del Morro.

Most of the islands in the inner estuary, which cover an area of some 640 km^2 (Ayon and Jara 1985), as well as the shorelines along both east and west coasts, had been extensively developed for shrimp farming. Many of the central areas of the islands had been almost completely covered with large shrimp ponds, replacing what would formerly have consisted of a complex of open *salitrals* fringed with mangroves. There appeared to be few, if any, parts of the estuary that had not been affected.

Isla Puna (Sectors 9-16) lies in the mouth of the Gulf of Guayaquil and protects the inner estuary from the direct influence of the open ocean. Extensive mud- and sandflats occurred along the north coast of the island in Sector 9, which contained the highest sector total for the island (210, mostly Willets). No shorebirds were observed on the tough sandy flats backed by low cliffs around the northeast corner of the island in Sector 10. Enormous soft mudflats occurred all along the eastern shore of Isla Puna (Sectors 11-13), although few shorebirds were observed, mostly small numbers of Whimbrels and Willets. Extensive shrimp pond development was again evident throughout the mangroves lining the shore.

The south shore of the island was sandier, with narrower sandy flats backed by beaches and some areas of muddy flats. Shrimp pond development was again extensive.

The west shore of the island is exposed to the ocean swell and consisted mainly of sandy beaches, backed in places by scrub and low dunes or forest and palm plantations. Small numbers of Sanderlings *Calidris alba* and Willets occurred along the shore.

Mangrove-lined shorelines with wide mudflats were found along the northwest flank of the island within the estuary; Willets (140) were again the most numerous species.

Table 14.1
Summary totals of Nearctic shorebirds in Ecuador

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Ecuador	1 385.5				
No. of birds		2 274	3 485	4 006	9 765
% of size-class total (Pacific Coast)		1.45	10.16	14.58	4.47
% of grand total (Pacific Coast)		1.04	1.60	1.83	4.47
% of size-class total (South America)		0.10	0.76	3.30	0.33
% of grand total (South America)		0.08	0.12	0.14	0.33

Table 14.2*a*
Totals of Nearctic shorebird species in Ecuador—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Ecuador	1 385.5				
No. of birds		5	230	2 039	2 274
% of species total (Pacific Coast)		10.87	0.23	3.49	1.45
% of size-class total (Pacific Coast)		0.00	0.15	1.30	1.45
% of grand total (Pacific Coast)		0.00	0.11	0.93	1.04
% of species total (South America)		1.16	0.21	0.09	0.10
% of size-class total (South America)		0.00	0.01	0.09	0.10
% of grand total (South America)		0.00	0.01	0.07	0.08

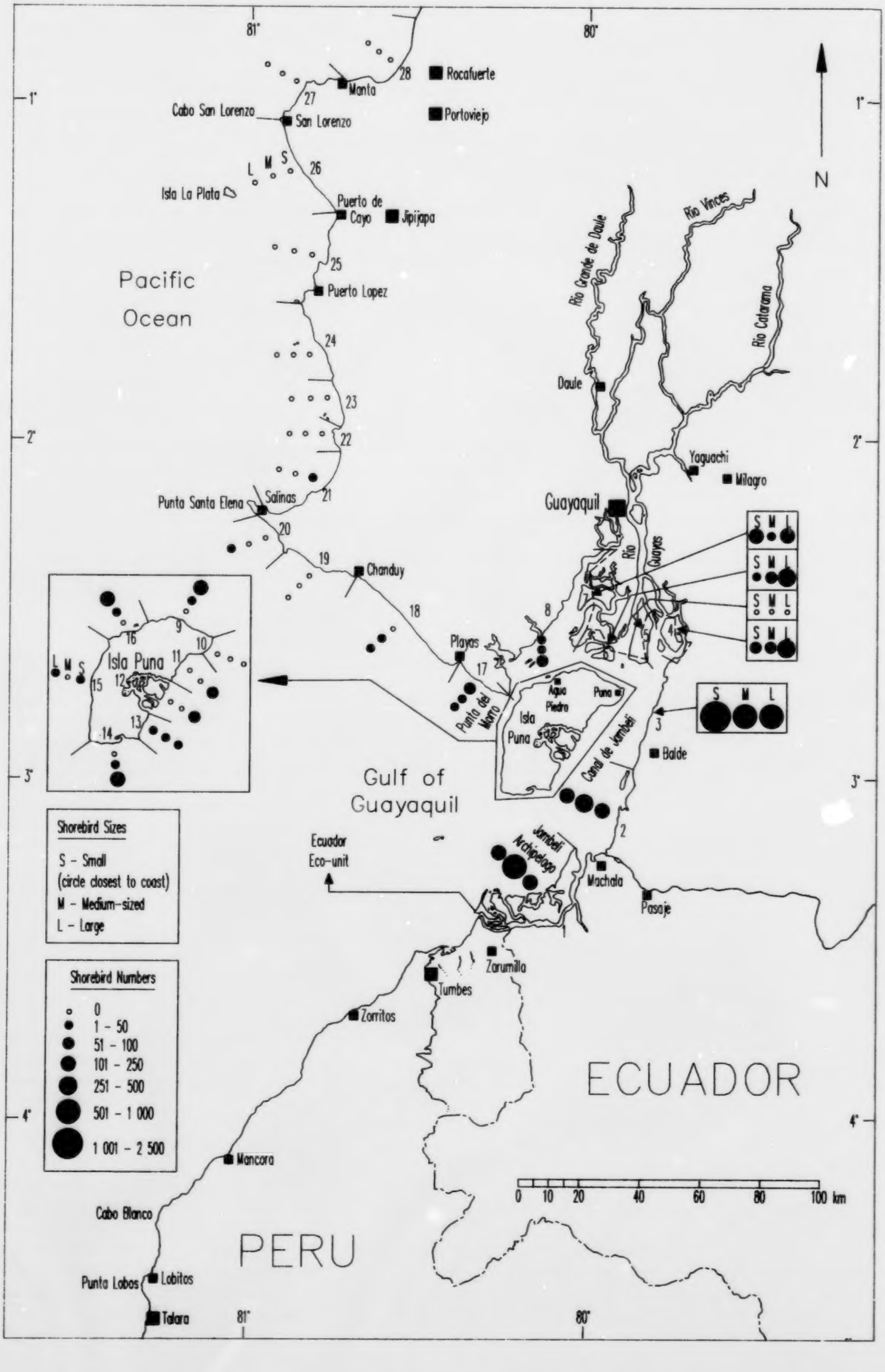
Table 14.2*b*
Totals of Nearctic shorebird species in Ecuador—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Ecuador	1 385.5						
No. of birds		1 082	109	135	825	1 334	3 485
% of species total (Pacific Coast)		37.66	4.63	5.70	57.73	5.32	10.16
% of size-class total (Pacific Coast)		3.15	0.32	0.39	2.41	3.89	10.16
% of grand total (Pacific Coast)		0.50	0.05	0.06	0.38	0.61	1.60
% of species total (South America)		3.97	0.46	0.15	1.69	0.72	0.76
% of size-class total (South America)		0.24	0.02	0.03	0.18	0.29	0.76
% of grand total (South America)		0.04	0.00	0.00	0.03	0.05	0.12

Table 14.2*c*
Totals of Nearctic shorebird species in Ecuador—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Unidentified large shorebird species	Total large shorebirds
Ecuador	1 385.5				
No. of birds		562	3 384	60	4 006
% of species total (Pacific Coast)		5.97	72.73	9.90	14.58
% of size-class total (Pacific Coast)		2.05	12.31	0.22	14.58
% of grand total (Pacific Coast)		0.26	1.55	0.03	1.83
% of species total (South America)		2.26	7.63	0.92	3.30
% of size-class total (South America)		0.46	2.79	0.05	3.30
% of grand total (South America)		0.02	0.12	0.00	0.14

Map 14.1 (Ecuador-1)
Distribution of Nearctic shorebirds along the southern coast of Ecuador


81°
80°
1°
2°
3°
4°
N
Rocafuerte
Manta
Portoviejo
Cabo San Lorenzo
San Lorenzo
Isla La Plata
Puerto de Cayo
Jipijapa
Puerto Lopez
Pacific Ocean
Punta Santa Elena
Salinas
Chanduy
Playas
Punta del Morro
Isla Puna
Agua Piedra
Puna
Canal de Jambelí
Jambelí Archipelago
Gulf of Guayaquil
Guayaquil
Río Guayas
Río Grande de Daule
Río Vinces
Río Catarama
Daule
Yaguachi
Milagro
Balde
Machala
Pasaje
Zarumilla
Tumbes
Zorritos
Mancora
Cabo Blanco
Punta Lobos
Lobitos
Talara
ECUADOR
PERU
Ecuador Eco-unit
L M S
S M L
1
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9
10
11
12
13
14
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17
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19
20
21
22
23
24
25
26
27
28
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
○ 0
● 1 - 50
● 51 - 100
● 101 - 250
● 251 - 500
● 501 - 1 000
● 1 001 - 2 500
0 10 20 40 60 80 100 km

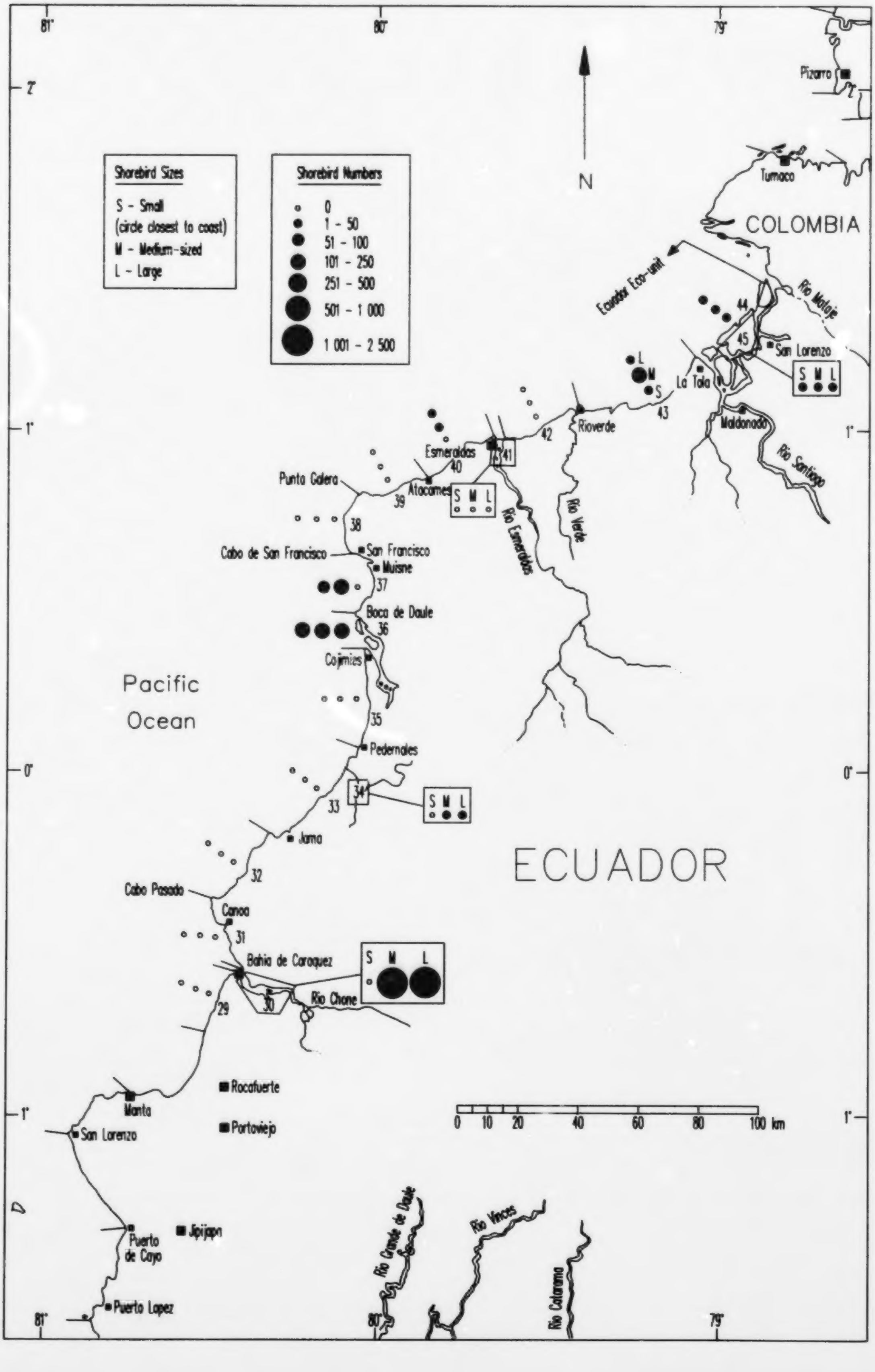
Table 14.3
Totals of Nearctic shorebirds in survey sectors in Map 14.1 (Ecuador-1)

Sector no.	Sector length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
1	51.2	0	43	73	116	130	42	0	0	335	507	54	94	148	771
2	69.6	0	0	165	165	134	3	22	0	175	334	16	108	124	623
3	46.2	0	0	1 164	1 164	112	0	90	30	320	552	41	486	527	2 243
4	34.8	0	0	80	80	40	0	0	0	60	100	271	135	406	586
5	18.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	42.4	0	0	15	15	50	0	4	0	1	55	0	360	360	430
7	40.0	2	0	180	182	30	0	0	0	0	30	1	160	161	373
8	64.7	0	0	27	27	5	3	0	0	0	8	9	48	57	92
9	24.7	0	0	0	0	2	0	0	0	0	2	3	205	208	210
10	8.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	15.1	0	0	0	0	0	0	0	0	0	0	16	50	66	66
12	12.3	0	0	0	0	0	0	0	0	0	0	10	47	57	57
13	10.3	0	0	10	10	20	0	0	0	0	20	5	4	9	39
14	17.1	0	0	0	0	20	0	0	0	0	20	28	74	102	122
15	34.9	0	45	0	45	0	0	0	0	0	0	1	14	15	60
16	15.2	0	0	0	0	2	0	0	0	0	2	8	136	144	146
17	21.5	0	83	0	83	36	5	0	0	0	41	3	7	10	134
18	45.4	0	0	0	0	1	0	0	0	0	1	6	10	16	17
19	28.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	15.9	0	0	0	0	0	0	0	0	0	0	2	0	2	2
21	34.6	3	20	0	23	0	0	0	0	0	0	0	0	0	23
22	9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	15.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	29.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	35.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	36.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	28.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	38.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	843.4	5	191	1 714	1 910	582	53	116	30	891	1 672	474	1 938	2 412	5 994

Table 14.4
Principal habitats in survey sectors in Map 14.1 (Ecuador-1)

Sector no.	Habitat description
1	Broad mud- and sandflats, dissected mangrove swamp / shrimp ponds, low-lying forest
2	Broad channelled mud- and sandflats, mangrove swamp / shrimp ponds / forest
3	Broad mudflats bordered by mangroves / forest
4	Estuarine mudflats around island, mangroves / shrimp ponds / forest
5	Estuarine mudflats around island, mangroves / shrimp ponds / forest
6	Estuarine mudflats around island, mangroves / shrimp ponds / forest
7	Estuarine mudflats around island, mangroves / shrimp ponds / forest
8	Estuarine mud- and sandflats, mangroves / shrimp ponds / forest
9	Broad sand- and mudflats, mangroves / shrimp ponds / low-lying forest
10	Sandflats / vegetated cliffs / forest
11	Broad mud- and sandflats, mangroves / shrimp ponds / forest
12	Mudflats, channelled mangrove swamp / forest
13	Broad mudflats, mangrove band / many shrimp ponds / forest
14	Sandflats with muddy sections / scrubby dunes, many shrimp ponds / low scrubby forest
15	Broad sand beach, some mudflats and mangroves at north end / scrub and low dunes changing to low forest and palm plantations
16	Wide mudflats, mangroves / shrimp ponds / forest
17	Sand beaches / low open forest
18	Sand beaches with occasional rocky headlands, some small river exits / low open forest, many shrimp ponds
19	Sand beaches with rocky headlands / some cliffs / scrub
20	Rocky shelving shore with occasional sand beaches / cliffs / scrub and salt pans
21	Rocky points with sand beaches / scrub and lagoon
22	Sand beaches / low cliffs / open forest
23	Long sand beaches / steep forested hills
24	Sand beaches giving way to steep eroded cliffs / open forest
25	Cliffs with occasional sandy bays / densely forested hills
26	Sand beaches / forested plain giving way to cliffs
27	Narrow rocky and sand beaches / cliffs / forest
28	Sand beaches with occasional shelving rocky headlands, small river exit / scrubby badlands and low-lying forest

Map 14.2 (Ecuador-2)
Distribution of Nearctic shorebirds along the northern coast of Ecuador



81°
80°
79°
2°
1°
0°
N
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
Pizarro
Tumaco
COLOMBIA
Ecuador Eco-unit
Rio Mataje
44
45
San Lorenzo
La Tola
S M L
L
M
S
43
Maldonado
Rio Santiago
Rioverde
42
41
Esmeraldas
40
Atacames
39
Punta Galera
38
Rio Esmeraldas
Rio Verde
Cabo de San Francisco
San Francisco
Muisne
37
Boca de Daule
36
Cojimies
Pacific
Ocean
35
Pedernales
34
33
Jama
32
ECUADOR
Cabo Pasado
Canoa
31
Bahia de Caraquez
30
29
Rio Chone
Rocafuerte
Portoviejo
Manta
San Lorenzo
0
10
20
40
60
80
100 km
Puerto
de Cayo
Jipijapa
Puerto Lopez
Rio Grande de Daule
Rio Vinces
Rio Catarama

Table 14.5
Totals of Nearctic shorebirds in survey sectors in Map 14.2 (Ecuador-2)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Unidentified large shorebird species	Total large shorebirds	Total shorebirds
29	23.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	53.3	0	0	0	400	0	0	700	0	1 100	64	1 245	0	1 309	2 409
31	30.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	31.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	9.8	0	0	0	0	0	5	0	10	15	2	26	0	28	43
35	32.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	42.3	10	240	250	6	24	14	95	9	148	8	103	0	111	509
37	27.2	0	0	0	0	0	0	0	250	250	3	0	60	63	313
38	24.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	22.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	27.2	0	0	0	0	0	0	0	50	50	0	20	0	20	70
41	13.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	35.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	48.7	26	0	26	72	32	0	0	112	216	7	31	0	38	280
44	33.4	0	50	50	16	0	0	0	12	28	3	12	0	15	93
45	42.7	3	35	38	6	0	0	0	0	6	1	9	0	10	54
Total	542.1	39	325	364	500	56	19	795	443	1 813	88	1 446	60	1 594	3 771

Table 14.6
Principal habitats in survey sectors in Map 14.2 (Ecuador-2)

Sector no.	Habitat description
29	Narrow sand beach / cliffs / forest with some small lakes
30	Brackish estuary with extensive mangrove swamp and mudflats / heavily forested hills
31	Sand beaches changing to steep cliffs, several small river exits / forested hills
32	Sand beaches with some shelving rock outcrops / forested hills
33	Sand beaches with some shelving rock outcrops / shrimp pond, forested hills
34	Inland; shrimp pond complex / forest
35	Sand beaches / low forested hills, farmland, palm plantations
36	Brackish estuary with extensive mud- and sandflats, mangroves / some shrimp ponds, forest
37	Sand beach, small estuary with mangroves and mudflats / forest
38	Narrow beach with occasional rocky outcrops / cliffs / steep forested hills
39	Rocky shoreline / well-forested gently rolling hills
40	Broad sand beach with occasional rocky outcrops / forest
41	Mudflats and brackish estuary / city
42	Broad sand beach, small river mouth / forest
43	Broad sandflats / low-lying forest
44	Sandflats and sandbars along outer edge of estuary complex
45	Brackish estuary island complex with extensive mudflats and mangroves / low-lying forest

The northeastern shore of the Gulf of Guayaquil (Sectors 17–20), between Punta del Morro and Punta Santa Elena, is fairly straight and sandy, consisting of Tertiary and Quaternary sediments with alternating cliffs and low-lying plains (Table 14.4). Small numbers of a variety of species were seen between Punta del Morro and Playas (Sector 17), including some 80 Sanderlings, although very few shorebirds were seen along the remaining beaches. Long beaches and some dunes extended along the coast in Sector 18, and many shrimp ponds were noted once more in the sandy hinterland. The coast became somewhat rockier in Sectors 19 and 20, with a sandy hinterland and salinas on the Santa Elena peninsula.

The coastline from Salinas to north of Manta (Sectors 21–28) consisted of sandy beaches alternating with cliffs and shore platforms cut into Tertiary and Cretaceous sediments and Cretaceous igneous rocks. Apart from the small flock of Sanderlings observed on the beach north of Salinas in Sector 21, this section of coast was more or less devoid of Nearctic shorebirds. Much of the shoreline was rocky or steep, with forested hills.

14.5.2. Northern Ecuador

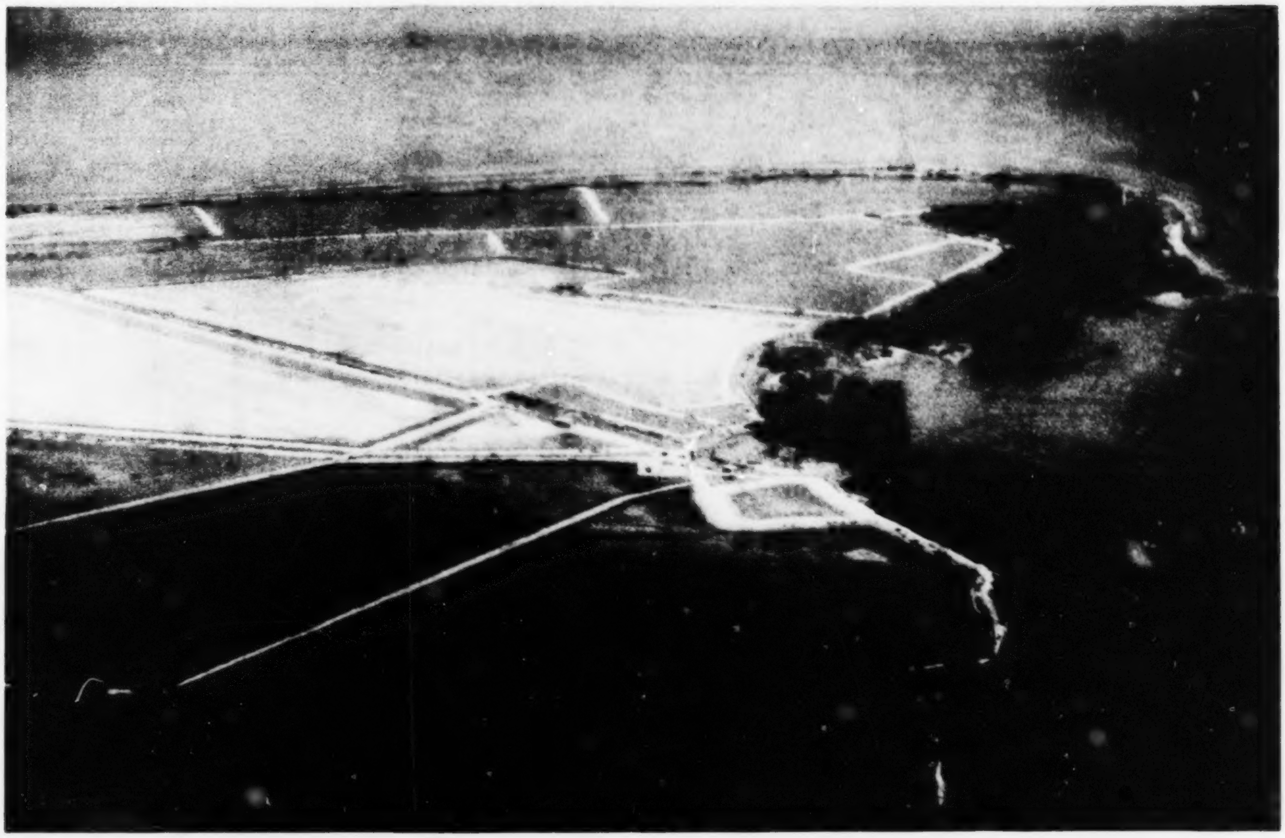
Sectors 29–45; Map 14.2 (Ecuador-2)

No shorebirds were observed on the outer shoreline between Manta and Cojimies (comprising Sectors 28, 29, 31–33, and 35; Tables 14.3 and 14.5), most of which was similar to the coastline between Salinas and Manta, consisting of a mixture of beaches, shelving rocky platforms, cliffs, and forested hills (Table 14.6).

The Bahia de Caraquez (Sector 30), where the Rio Chone reaches the coast, supported the highest numbers of shorebirds found outside the Gulf of Guayaquil and Guayaquil estuary and appeared to be one of the most important areas for shorebirds wintering in Ecuador. The total of 2400 represented 24.7% of the total for Ecuador and included important concentrations of Willets (1200), dowitchers (700), and Black-bellied Plovers (400) (36.8, 84.8, and 37.0% of the respective Ecuadorian species totals) (Table 14.5). Fairly extensive mudflats and mangrove stands have developed at Bahia de Caraquez, particularly on the north side and inner parts of the estuary. Shrimp pond developments have been started in the mangroves.

Sector 34 comprised the shrimp pond developments at the mouths of the Rio Jama and the river south of Pedernales. Practically all available river mouth wetlands on the coast contained shrimp ponds; small numbers of Willets, yellowlegs, and Whimbrels were found around the ponds.

The Cojimies Peninsula forms a barrier enclosing a mangrove-lined bay, with sandbars developing at its mouth. Mudflats occur within the bay, and sandflats near its mouth. Some shrimp pond development is occurring in the estuary. The area (Sector 36) contained fairly small numbers, although an interesting variety, of shorebirds, including 240 peeps and smaller numbers of Black-bellied Plovers, turnstones, yellowlegs, dowitchers, Whimbrels, and Willets, with some Sanderlings along the sandier outer parts. Another small river mouth, with mudflats and mangroves, occurred at Muisne (Sector 37) and contained



Shrimp ponds, Gulf of Guayaquil, Ecuador. Widespread construction of shrimp ponds has affected many of the mangrove forests surrounding the extensive mudflats of the Gulf of Guayaquil.

small numbers (310) of a similar variety of species. Together, the inlets at Cojimies and Muisne contained 820 shorebirds, some 8.4% of the Ecuadorian total, and represented some of the most significant shorebird habitats along this part of the coast.

No shorebirds were observed on the outer coastline between Cabo de San Francisco and the Rio Verde (Sectors 38–42). In this area, cliffs and shore platforms cut block-faulted Miocene silty claystones; rocky slabs occurred along the shore in Sectors 38 and 39 around Punta Galera, and broad expanses of sandy beach were found in Sectors 40 and 42 between Atacames and the Rio Verde (Table 14.6). The small number of Willets (20) and medium-sized shorebirds (50) noted in Sector 40 were found in the estuary of the Rio Atacames. No shorebirds were found in the estuary of the Rio Esmeraldas. Mudflats occur on the northeastern sides of both river mouths, apparently as a result of the longshore drift in this direction (Ayon and Jara 1985).

Broad sandflats ran along the coast between the Rio Verde and the mouth of the Rio Santiago (Sector 43); small numbers of a variety of species, including Sanderlings, Black-bellied Plovers, turnstones, Whimbrels, and Willets, were found along the shore.

An extensive complex of mangroves and marshes (Sector 45), covering some 500 km^2, is found where the Rio Santiago and other rivers enter the coast between La Tola and the border with Colombia, at the Rio Mataje. Extensive mudflats occur along the river channels between the islands, although relatively few shorebirds were found either in these habitats or along the outer sandy shore (Sector 44).

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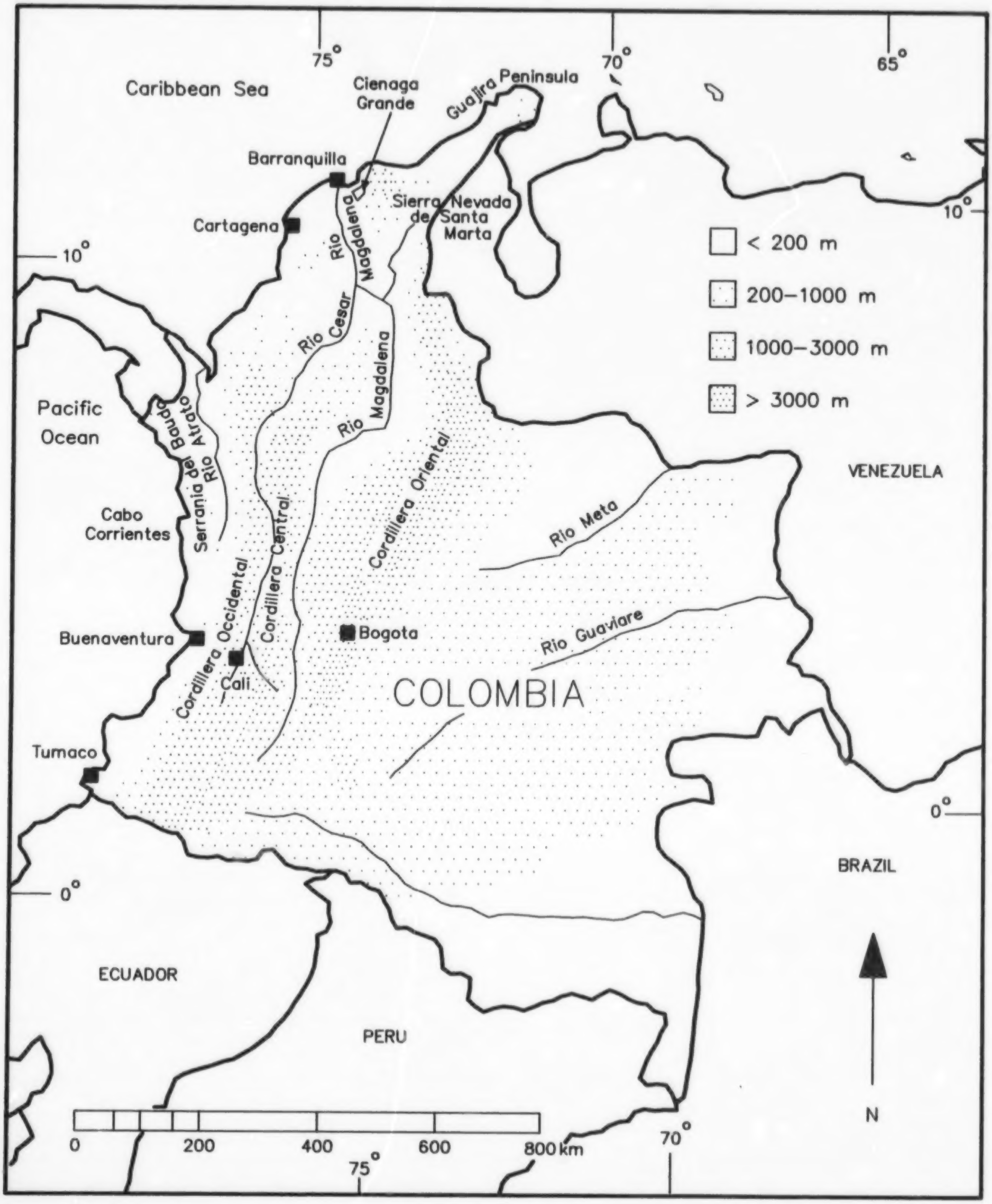
Figure 15.1
Some of the main geographical features of Colombia


75°
70°
65°
Caribbean Sea
Cienaga Grande
Guajira Peninsula
Barranquilla
Cartagena
Rio Magdalena
Sierra Nevada de Santa Marta
10°
< 200 m
200–1000 m
1000–3000 m
> 3000 m
Rio Cesar
Rio Magdalena
Pacific Ocean
Serrania del Baudo
Rio Atrato
Cordillera Oriental
VENEZUELA
Cabo Corrientes
Rio Meta
Cordillera Central
Cordillera Occidental
Buenaventura
Bogota
Rio Guaviare
Cali
COLOMBIA
Tumaco
0°
BRAZIL
ECUADOR
PERU
N
0
200
400
600
800 km

Chapter 15

Colombia

R.I.G. Morrison, R.K. Ross, C. Downes, J.E. Morales S., and J.V. Rodriguez M.

15.1. General geography

Colombia occupies the northwestern corner of South America; it has a surface area of some 1 142 000 km^2 and is situated between 4°17′N and 12°24′N and between 66°51′W and 79°03′W (Stibane 1975). It is bordered to the east by Venezuela, to the north by the Caribbean Sea and Panama, to the west by the Pacific Ocean, to the south by Ecuador and Peru, and to the southeast by Brazil and is linked to Central America by the Isthmus of Panama (Fig. 15.1).

Colombia has a fairly complex geomorphology. There are two main geomorphological regions: the Orinoquian (Llanos) and the Amazonian, lowland areas occupying the eastern part of the country, and the Andes mountains, which reach their terminus in Colombia and are the dominant element in west and central Colombia (Stibane 1975).

The Andes form a series of parallel ranges, which cut across the country from the Ecuadorian border towards the north–northeast. The Andes themselves are divided into the Cordillera Occidental, the Cordillera Central, and the Cordillera Oriental. Two areas of lowlands exist, one lying off the Caribbean Sea and the other off the Pacific Ocean. The Pacific Lowland area covers 1500 km along the Pacific Ocean from Panama to Ecuador and is separated from the Cordillera Occidental by the Atrato Valley. This region contains the Serrania del Baudo, which extends from the border with Panama south to 5°N (Case *et al.* 1971). South of Cabo Corrientes, there is a narrow coastal plain, with narrow sandy beaches bordered by mangrove forests and fronted by large mudflats. A cliffed shoreline exists at several places along this coast.

Some 1760 km of shoreline are found along the Caribbean Lowlands on the north coast of Colombia. Major mountain ranges include the Sierra Nevada de Santa Marta; to the east, the northern extension of the Cordillera Occidental, the Sierra de Perija; and, in the extreme northeast, the Guajira Peninsula. Sandy beaches line the coast south to Cape San Juan de Guia, where cliffs and pocket beaches occur. South of Santa Clara, the coastal zone is dominated by the delta of the Rio Magdalena and mangrove-covered mudflats and beach ridges (Psuty and Mizobe 1982).

The Andean system divides into three cordilleras at the border of Ecuador and Colombia (Irving 1975), separated by deep tectonic valleys. The Magdalena Valley separates the Cordillera Oriental and Cordillera Central, and the Cauca and Patia valleys separate the Cordillera Central and the Cordillera Occidental (Case *et al.* 1971). The western and central cordilleras terminate in Colombia, but the eastern cordillera continues into Venezuela.

The Cordillera Occidental in Colombia forms an extension of the Ecuadorian Cordillera and consists mainly of folded and faulted upper Mesozoic sedimentary and volcanic rocks, intruded by mid-Tertiary plutons, which are bodies of rock formed beneath the surface (Case *et al.* 1971; Irving 1975). The Cordillera Central is a continuation of the Cordillera Real of Ecuador and is mainly composed of metamorphic Paleozoic strata that have been intruded by small Paleozoic – Lower Triassic plutons and upper Mesozoic plutons (Oppenheim 1952). In northern Colombia, the central and western cordilleras are overlapped and concealed by the Tertiary cover of the Caribbean coastal plain (Morrison 1962).

The Cordillera Oriental splits at 7°30′N, with the main branch passing into Venezuela and a smaller branch, the Serrania de Perija, extending northwards along the western side of the Maracaibo Basin (Morrison 1962).

The triangular block of the Sierra Nevada de Marta lies on the rim of the Caribbean Basin to the west of the Serrania de Perija (Irving 1975). Its peaks are the highest on the north coast of South America, reaching an altitude of nearly 5800 m. This isolated mountain range is separated from the Magdalena Valley plains and the Cordillera Central by a north–south fault (Oppenheim 1952) and is made up of igneous and metamorphic rocks, mainly of Paleozoic age, but including some Mesozoic rocks intruded by granite during the Cretaceous (Morrison 1962). The Guajira Peninsula, running along the border with Venezuela, is the northernmost arm of the Andean system (Psuty and Mizobe 1982).

After the folding of the Andes, large quantities of material were stripped from the cordilleras, transported through the drainage system of the Cauca and Magdalena rivers, and deposited as alluvial fans that now form terraces and mesas along the margins of the main drainage system.

The northwestern corner of Colombia is one of the least understood tectonic areas in South America, partly because of the complex geological structure within a relatively small area (Case *et al.* 1971). Little is known about the geology of the mountainous Pacific coast of northwest Colombia. At the Isthmus of Panama, where the South and Central American continents join, the southeast-trending hills of Panama veer southward to become the Serrania del Baudo, or Pacific Coastal Hills (Irving 1975), the westernmost range of Colombia running south to Buenaventura. In the south, the depression merges with the Pacific Coastal Basin of Colombia (Irving 1975).

Colombia has a complex and active tectonic history. Between 1575 and 1946, 102 significant earthquakes were recorded (Oppenheim 1952), with about 50% occurring in the region bordering Ecuador. In 1979, an earthquake occurred offshore about 80 km southwest of Tumaco, near the Colombian/Ecuadorian border. The effects of the earthquake, which was predicted several years before (Herd *et al.* 1981), were felt over 200 km of coast from Tumaco to Buenaventura, causing a 1.6-m subsidence of the shore (Herd *et al.* 1981; Schwartz 1985), covering many beaches that were formerly dry at high tide, and drowning much of the coastal vegetation. An unknown amount of uplift occurred along the continental slope, resulting in a tsunami that flooded the coastline.

15.2. Pacific coast

15.2.1. Geography and geomorphology

The Pacific coast of Colombia is cliffed in the northern half and mangrove-fringed in the south (Psuty and Mizobe 1982; Schwartz 1985). It can be classified into two types: (1) a mountainous coast of cliffed headlands, alternating with sandy beaches from Cabo Corrientes to Panama; and (2) a low coast of rain-forest-covered hills and flat alluvial plains, running from Ecuador north to Cabo Corrientes (West 1954, 1957). Tides are semidiurnal, with a spring range of 4–6 m (Davies 1973). The entire coast is influenced by oceanic swell, with net shoreline drift occurring towards the north (West 1956).

In the north, the coastline is high and cliffed, with deep inlets and harbours fronted by sandy beaches south of the border with Panama (Reichel-Dolmatoff 1965); this shoreline continues south to Cabo Corrientes, where the Serrania del Baudo lies close to the shore. Along the coast, the Serrania del Baudo has been eroded to form headlands, some with cliffs 60 m high, most of which are covered with dense rain forest. From Punta Ardita southward, the cliffs occur in stretches of 3–5 km, interrupted by coves with sandy beaches. Caves and arches are common. Along the mountain coast, 40% of the land is fringed by beaches. The longest stretch of sandy beach (25 km), interrupted by stream estuaries, is found between Punta Ardita and Coredo.

The offshore islands of the Rocas de Otavia off Cabo Marzo, the cluster of islets off Punta Juribida, and the Negritos near Bahia de Buenaventura are examples of headlands previously joined to the mainland. These islands are heavily used by seabirds (West 1957).

Between the Serrania del Baudo and the cordilleras lies the Atrato – San Juan depression, made up of the Atrato and the San Juan river valleys. The Rio Atrato is short (280 km), running from near Quibdo to the Golfo de Uraba on the Caribbean coast. It is a wide, deep river, with a water level reflecting the high rainfall of its drainage areas in the Pacific Lowlands. In the lower half of the river basin, swamps and numerous small lakes, or *cienagas*, cover the greater part of the lowlands. During the drier months of January–March, the *cienagas* may dry out completely.

In contrast to the wide swampy basin of the Atrato, the alluvial plain of the Rio San Juan (190 km) is fairly narrow and often absent (West 1957). The San Juan carries a heavier sediment load than the Atrato, because it lacks the backswamp area where much of the sediment from the Rio Atrato settles out. As a result, an arc-shaped delta three times the size of that of the Atrato has developed at the mouth of the Rio San Juan (West 1957).

South of Cabo Corrientes, the short rivers and streams running from the Cordillera Occidental have built a narrow coastal plain (8–24 km wide; Psuty and Mizobe 1982). Deep mangrove swamps and estuaries, backed by freshwater swamps, are found along the plain, which widens significantly (55 km wide; West 1957) from Buenaventura south to Tumaco over the region of the San Juan de Micay, Mira, and Patia deltas. These rivers drain the interior basin of the Cordillera Occidental and are the major source of alluvium along the coast (West 1957). The coast is fringed by a narrow sandy beach fronted by large mudflats (Psuty and Mizobe 1982), particularly in areas protected from strong wave action, such as bays or estuaries. The rest of the shore that is exposed to strong wave action (45%) is fringed by short sand beaches.

Tidal currents and scouring are important depositional and erosional factors along the shoreline. In many areas, small banks of fine sand are exposed close to the shoreline and become temporary roosting places for large numbers of seabirds (West 1957). A low cliffed shore occurs in three locations: a 40-km stretch west of Buenaventura Bay, a short stretch south of Buenaventura, and a third stretch near Tumaco (West 1956; Schwartz 1985). South of Buenaventura, a belt of low hills (30–65 km wide) lies between the coastal fringe and the Cordillera Occidental, forming the greater part of the Pacific Coastal Plain (West 1957). Among these hills, steep slopes are common; along the streams intersecting the hills, Pleistocene terraces with flat surfaces provide good farmland (West 1957).

15.2.2. Climate

The climate of the Pacific Coastal Lowlands of Colombia features high, but not excessive, temperatures, moist air, and abundant rainfall.

The mean temperature of the coast rarely exceeds 28°C, with a maximum and minimum of 31 and 22°C, respectively (West 1954). Diurnal fluctuations greatly exceed seasonal differences in temperature within the lowlands (< 1°C), as occurs along the Caribbean coast and in other equatorial areas.

The average annual rainfall for the coast is 5500 mm, with the northern and southern extremes receiving 3000 mm and the upper valley of the Rio Atrato receiving as much as 10 000 mm. Most (80%) of the rain falls between 1900 and 0700 hours.

15.2.3. Vegetation

The major vegetation type of the Pacific Lowlands is the rain forest, which covers the Serrania del Baudo and the western slopes of the Cordillera Occidental to 3000 m. It extends northwards into Panama and southwards into Ecuador. The number of deciduous plants increases in the north and south, where a dry season occurs near the coast.

A distinct zonation of habitats and vegetation is found along mangrove coastlines (West 1954, 1956, 1957). The outermost zone consists of the belt of shallow water and mudflats occurring along the shoreline. Progressing inland, there is a series of sand beaches, interspersed with tidal inlets, estuaries, and mudflats; vegetation of the beach zone consists of low shrubs, creeping vines, and coarse grass. Behind this is the mangrove zone, consisting of a dense forest of various mangrove species up to 1–5 km in width. Freshwater swamps, flooded by fresh or brackish water from rivers during high tide, are dominated by the giant nato tree *Mora megistosperma* and clumps of the naidi palm *Euterpe* sp. Equatorial rain forest occurs on higher ground farther inland.

15.3. Caribbean coast

15.3.1. Geography and geomorphology

The geomorphology of the Caribbean coastline ranges from the arid to semiarid Guajira Peninsula in the northeast to the jungles of Darien in Panama. The Guajira Peninsula itself is flat and sandy, with beaches and dunes along the coast (Schwartz 1985). There is an active coral reef at the tip of the peninsula (Psuty and Mizobe 1982). Rocky sea cliffs with pocket beaches occur to the east of Santa Marta; to the southeast, the pyramid-shaped Sierra Nevada de Santa Marta rises to over 5800 m from generally low and level surroundings. The coastal plain continues southwest of the Sierra Nevada, changing from desert to rolling hills of semiarid savannah.

The region southeast of the Sierra Nevada is drained by the Rio Cesar, which flows south to join the Rio Magdalena (Shanahan 1964), which in turn flows northwards to join the Caribbean coast near Barranquilla. The Rio Magdalena has a wide, marshy floodplain covered in lagoons, swamps, and channels. East of Barranquilla, the Cienaga Grande consists of an extensive complex of lagoons bordered by mangroves and wetlands. The fluctuating activity of the distributaries, which transport large quantities of sediment into the Magdalena, are responsible for the periods of accretion and erosion occurring along the shoreline (Psuty and Mizobe 1982). Another lagoon, fringed with mangroves, occurs at Cartagena. To the east, the Rio Sinu, which runs parallel to the Rio Magdalena, drains the eastern slope of the Pacific Cordillera (Cordillera Occidental) (Shanahan 1964) and enters the Caribbean in a delta in the Golfo de Morrosquillo.

At the western end of the Caribbean coast, the coastal plain merges with the rain forest of the Golfo de Uraba, which forms the submerged northward end of the longitudinal Atrato Valley (Shanahan 1964). A low, marshy floodplain exists, fringed by mangrove swamps and interrupted by cliffs and boulder-strewn beaches (Reichel-Dolmatoff 1965). The Rio Atrato empties into the southwest side of the Golfo de Uraba, forming a large delta, which supplies sediment to the nearby shoreline. Active sedimentation is extending the delta, with the development of mudflats and natural levees (low banks that extend seaward) gradually forming bays. The coastal lowland belt is bounded on the south and west by the mountains of the Panama border, which extend across the lower valley of the Atrato (Vann 1959). The Rio Atrato fluctuates widely in level in its lower course, being lowest in February and highest in the summer floods.

Two stretches of narrow, flat beaches, the Playa de Barbacoas and the Playa de Torena, are found along the coastline of the delta. The beaches are made of fine sand and are located in areas near river mouths open to the sea; both serve as sources of sand. The rest of the delta is formed of mud, silt, and organic accumulations.

15.3.2. Climate

The climate of Caribbean Colombia is mainly tropical, with seasons marked more by fluctuations in the amount of rainfall than by temperature regime.

The annual mean air temperature at sea level on the Caribbean coast is 28–30°C (Snow 1976). Diurnal temperature fluctuation (9°C) is much greater than the seasonal variation, which differs by only 2°C between the warmest and the coolest months.

On the Caribbean coastal plain, the rainy season extends from April to November, followed by a dry season from December to March. Mean annual rainfall along the coast is 1500 mm, occurring mainly between May and October, with separate maxima in May–June and September–October (Snow 1976). The highest annual rainfall (4000 mm) occurs in a narrow strip on the west face of the Sierra Nevada (Snow 1976). Along the middle of the coast, precipitation is light, and the vegetation approaches that characteristic of deserts (Carlson 1952). Steppe habitats are found northeast of the Sierra Nevada. The Guajira Peninsula is a hot desert area, covered sparsely with shrubs, cacti, and bromeliads, except in the northeast in the Sierra de la Macuira, where mist forest occurs. Some rain occurs between October and November, but during the dry season the trade winds blow over the flat peninsula and there are no barriers to condense the moisture. Large stretches of land are barren (Dugand 1946). The Guajira Peninsula receives the lowest annual rainfall on the Caribbean coast (<300 mm).

The coastal plain continues to the southwest, desert giving way to semiarid savannah covered with shrubby deciduous trees, as far as the marshy floodplain of the Rio Magdalena delta. Annual rainfall increases west of the Magdalena delta, and rain forest begins at the Golfo de Uraba.

15.3.3. Vegetation

Three major vegetational zones are found in the delta of the Rio Atrato (Vann 1959): (l) a mangrove community along the shore, dominated by *Rhizophora mangle*, *Laguncularia racemosa*, and *Muellera frutescens*, with an undergrowth composed mainly of *Pavonia racemosa*, *Hibiscus*, and *Drepanocarpus*; (2) areas of natural levees extending seaward, with a distinctive vegetation characterized by *Raphia taedigera*, the palm *Pentaclethra macroloba*, and *Pachira aquatica*; and (3) the lake zone, consisting of two communities—a sedge/grass community, in which grasses and spiny shrubs are prominent, and a palm community, forming a belt of high growth, dominated by a variety of palms, including *Phytelephas seemanii*, *Ammandra decasperma*, *Euterpe rhodoxyla*, and *Mauritiella* spp. Low shrubs, vines, and creepers are found along the beach.

15.4. Shorebird distribution

A total of some 43 000 Nearctic shorebirds was counted in Colombia, of which 31 900 (74.6%) occurred on the Pacific coast and 11 000 (25.6%) on the Caribbean coast (Table 15.1). The majority of the small (83.3%) and large (95.2%) shorebirds occurred on the Pacific coast, whereas the distribution of medium-sized species in each region was more even (50.9% on the Pacific coast). The totals of 24 700 small and 6200 medium-sized shorebirds on the Pacific coast represented 15.8 and 18.1% of the regional Pacific Coast size-class totals, respectively. The most important areas on the Pacific coast appeared to be the mangrove shorelines around Tumaco and Guapi; on the Caribbean coast, the most notable areas occurred around the mouth of the Rio Magdalena near Barranquilla.

Table 15.1
Summary totals of Nearctic shorebirds in eco-units in Colombia

Eco-unit/Parameter	Eco-unit length (km)	Small shorebirds	Medium-sized shorebirds	Large shorebirds	Total shorebirds
Pacific	746.9				
No. of birds		24 718	6 224	999	31 941
% of size-class total (Colombia)		83.3	50.9	95.2	14.62
% of size-class total (South America)		1.06	1.36	0.82	1.09
% of size-class total (Pacific Coast)		15.78	18.14	3.64	14.62
% of grand total (Pacific Coast)		11.32	2.85	0.46	14.62
Caribbean	853.7				
No. of birds		4 955	6 014	50	11 019
% of size-class total (Colombia)		16.7	49.1	4.8	0.44
% of size-class total (South America)		0.21	1.32	0.04	0.38
% of size-class total (North Coast)		0.24	1.79	0.08	0.44
% of grand total (North Coast)		0.20	0.24	0.00	0.44
All Colombia	1 600.6				
No. of birds		29 673	12 238	1 049	42 960
% of size-class total (South America)		1.27	2.68	0.86	1.47
% of grand total (South America)		1.02	0.42	0.04	1.47

The majority of small shorebirds counted in Colombia consisted of small sandpipers, or peeps, on both Pacific (96.6%) and Caribbean (98.3%) coasts. The Pacific Coast total of 23 900 peeps was regionally important, representing some 40.9% of the birds in this category on the Pacific coast (Table 15.2*a*). Areas of particular concentration included the bays near Tumaco and especially the coastline near Guapi. Sanderlings were seen regularly in moderate numbers along the beaches of the Pacific coast, both north and south of Buenaventura, the Pacific Coast total of 830 representing 0.8% of the total on the west coast of South America.

On the Pacific coast, medium-sized and large species tended to concentrate along the mangrove coasts near Tumaco and Guapi, including Black-bellied Plovers *Pluvialis squatarola*, Ruddy Turnstones *Arenaria interpres*, dowitchers *Limnodromus* spp., Whimbrels *Numenius phaeopus*, and Willets *Catoptrophorus semipalmatus*. Pacific Coast totals of some species, although small compared with those on the north coast of the continent, did form significant proportions of the totals for the west coast of South America, including Black-bellied Plovers (420, 14.6%), dowitchers (600, 42.3%), and Willets (680, 14.6%) (Table 15.2*b*, 15.2*c*).

On the Caribbean coast, important concentrations of Black-bellied Plovers and other medium-sized shorebirds, as well as of peeps, occurred around the mouth of the Rio Magdalena at Barranquilla. Important concentrations of peeps and dowitchers were found on a nearshore brackish lagoon west of Barranquilla near Galerazamba. Moderate concentrations of small and medium-sized shorebirds occurred on the coast and coastal wetlands near the mouth of the Rio Sinu on the south side of the Golfo de Morrosquillo, on the wetlands south of Cartagena, and in the Cienaga de Tesca at Cartagena.

15.4.1. Pacific eco-unit

Sectors 1–24; Maps 15.1 (Colombia-1) and 15.2 (Colombia-2)

For logistical reasons, surveys in southern Colombia started near Tumaco, the mangrove coastlines towards Cabo Manglares and the border with Ecuador being beyond survey range.

A relatively broad coastal plain occupies the entire southern part of the coastline between Buenaventura and Tumaco. The coastal lowlands result from the deposition of fluvial sediments brought down from the mountains (Psuty and Mizobe 1982) and widen considerably around the deltas of the Rio San Juan de Micay, Rio Patia, and Rio Mira; they are underlain by Tertiary sediments. The coastal topography has been considerably affected by the earthquake in 1979, which resulted in subsidence of up to 1.6 m in some areas, followed by subsequent reworking of sediments and restabilization of the coastline.

Surveys started just to the west of Tumaco, where sandy beaches occurred along the outer shore, backed by muddy, mangrove-lined creeks. Peeps and Black-bellied Plovers were common on the muddier areas, and the 30 Sanderlings *Calidris alba* observed in Sector 1 were found along the ocean beaches (Table 15.3).

The bay between Tumaco and Punta Cascajal, the Ensendada de Tumaco, was generally lined with mangroves, and extensive soft mudflats were found around its inner parts, particularly in Sector 2 near the mouths of the rivers entering the bay (Table 15.4). Some sandy beaches backed by vegetated bluffs occurred in Sector 3; rocky areas of sea cliffs are uncommon along the southern coast, being found only near Tumaco and west and south of Bahia de Buenaventura (West 1956). Sectors 1–3 held 3500 shorebirds, some 11.1% of the eco-unit total. Notable numbers of a variety of species and size categories were present, including peeps (1800, 7.5% of the eco-unit total), total medium-sized shorebirds (1500, 23.5%), and substantial proportions of the totals of several identified species, including Black-bellied Plovers (280, 65.9%), dowitchers (390, 64.9%), and Whimbrels (130, 41.3%). These totals, although small in continental terms, were nevertheless regionally significant (Table 15.3).

At Punta Cascajal, a long, wave-washed beach ran northwards, forming the outer shoreline of Sectors 4–6. The beach was broken at regular intervals by creeks and river mouths, some but not all with associated mudflats; behind the beach lay extensive mangroves and lowland forest. Sanderlings were seen regularly along the outer beaches, the highest number observed on the southern part of the coast (140) occurring in Sector 4. Only small numbers of other species were seen, often near the creek mouths.

Sector 6 ended partway along the outer shoreline of the Sanquianga National Park, a vast complex of creeks,

Table 15.2a
Totals of Nearctic shorebird species in eco-units in Colombia—small shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds
Pacific	746.9				
No. of birds		8	827	23 883	24 718
% of species total (Pacific Coast)		17.39	0.84	40.87	15.78
% of species total (South America)		1.86	0.74	1.08	1.06
% of size-class total (Pacific Coast)		0.01	0.53	15.25	15.78
% of grand total (Pacific Coast)		0.00	0.38	10.93	11.32
Caribbean	853.7				
No. of birds		28	56	4 871	4 955
% of species total (North Coast)		7.78	1.28	0.23	0.24
% of species total (South America)		6.50	0.05	0.22	0.21
% of size-class total (North Coast)		0.00	0.00	0.23	0.24
% of grand total (North Coast)		0.00	0.00	0.20	0.20
All Colombia	1 600.6				
No. of birds		36	883	28 754	29 673
% of species total (South America)		8.35	0.79	1.30	1.27
% of size-class total (South America)		0.00	0.04	1.24	1.27
% of grand total (South America)		0.00	0.03	0.98	1.02

Table 15.2b
Totals of Nearctic shorebird species in eco-units in Colombia—medium-sized shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds
Pacific	746.9						
No. of birds		419	189	20	604	4 992	6 224
% of species total (Pacific Coast)		14.58	8.03	0.84	42.27	19.92	18.14
% of species total (South America)		1.54	0.80	0.02	1.24	2.69	1.36
% of size-class total (Pacific Coast)		1.22	0.55	0.06	1.76	14.55	18.14
% of grand total (Pacific Coast)		0.19	0.09	0.01	0.28	2.29	2.85
Caribbean	853.7						
No. of birds		1 241	175	20	1 558	3 020	6 014
% of species total (North Coast)		5.22	0.86	0.02	3.28	1.99	1.79
% of species total (South America)		4.55	0.74	0.02	3.19	1.63	1.32
% of size-class total (North Coast)		0.37	0.05	0.01	0.46	0.90	1.79
% of grand total (North Coast)		0.05	0.01	0.00	0.06	0.12	0.24
All Colombia	1 600.6						
No. of birds		1 660	364	40	2 162	8 012	12 238
% of species total (South America)		6.09	1.55	0.04	4.42	4.32	2.68
% of size-class total (South America)		0.36	0.08	0.01	0.47	1.75	2.68
% of grand total (South America)		0.06	0.01	0.00	0.07	0.27	0.42

Table 15.2c
Totals of Nearctic shorebird species in eco-units in Colombia—large shorebirds

Eco-unit/Parameter	Eco-unit length (km)	Whimbrel	Willet	Total large shorebirds
Pacific	746.9			
No. of birds		320	679	999
% of species total (Pacific Coast)		3.40	14.59	3.64
% of species total (South America)		1.29	1.53	0.82
% of size-class total (Pacific Coast)		1.16	2.47	3.64
% of grand total (Pacific Coast)		0.15	0.31	0.46
Caribbean	853.7			
No. of birds		29	21	50
% of species total (North Coast)		0.19	0.05	0.08
% of species total (South America)		0.12	0.05	0.04
% of size-class total (North Coast)		0.05	0.03	0.08
% of grand total (North Coast)		0.00	0.00	0.00
All Colombia	1 600.6			
No. of birds		349	700	1 049
% of species total (South America)		1.40	1.58	0.86
% of size-class total (South America)		0.29	0.58	0.86
% of grand total (South America)		0.01	0.02	0.04

Map 15.1 (Colombia-1)
Distribution of Nearctic shorebirds along the southern Pacific coast of Colombia

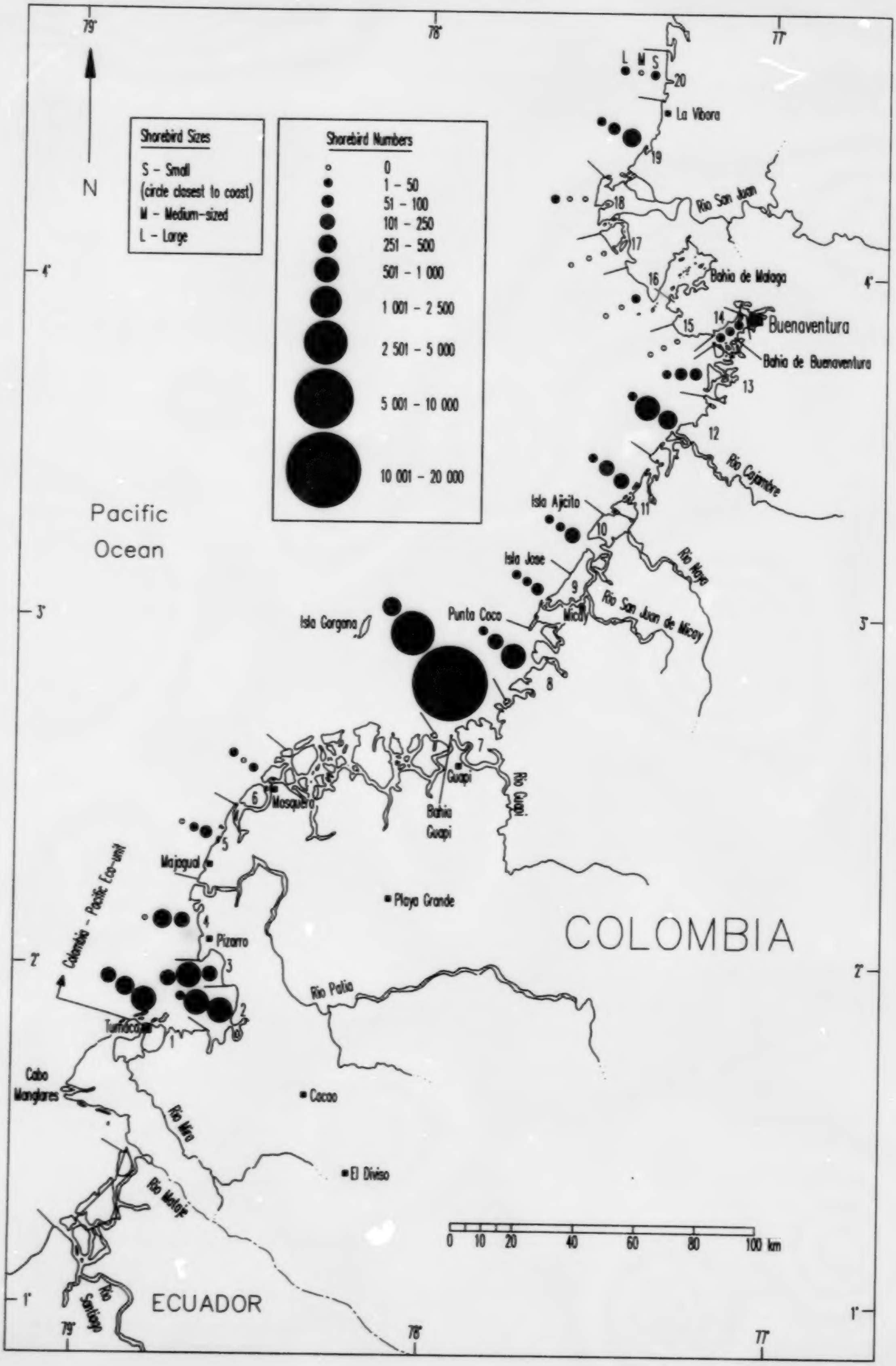

79°
78°
77°
4°
3°
2°
1°
N
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
5 001 - 10 000
10 001 - 20 000
L M S
20
La Vibora
19
18
Río San Juan
17
16
Bahía de Málaga
15
14
Buenaventura
Bahía de Buenaventura
13
12
Río Cajambre
Isla Ajicito
11
10
Río Naya
Isla José
9
Micay
Río San Juan de Micay
Punta Coco
Isla Gorgona
Pacific
Ocean
8
7
Guapi
Bahía
Guapi
Río Guapi
6
Mosquera
5
Majagual
Playa Grande
4
Pizarro
Colombia - Pacific Eco-unit
3
COLOMBIA
Río Patía
2
Tumaco
1
Cabo
Manglares
Cocao
Río Mira
El Diviso
Río Mataje
0 10 20 40 60 80 100 km
Río
Santiago
ECUADOR

Table 15.3
Totals of Nearctic shorebirds in survey sectors in Map 15.1 (Colombia-1)

Sector no.	Sector length (km)	Spotted Sand-piper	Sander-ling	Uniden-tified small shorebird species	Total small shore-birds	Black-bellied Plover	Ruddy Turn-stone	Yellow-legs species	Dowit-cher species	Uniden-tified medium-sized shorebird species	Total medium-sized shore-birds	Whim-brel	Willet	Total large shore-birds	Total shore-birds
1	29.5	0	30	580	610	45	40	0	0	235	320	78	45	123	1 053
2	30.1	0	0	1 000	1 000	12	0	0	52	500	564	4	24	28	1 592
3	21.5	1	0	200	201	219	0	0	340	20	579	50	71	121	901
4	29.6	0	138	24	162	2	0	0	0	301	303	0	0	0	465
5	30.6	0	8	46	54	10	0	0	0	0	10	0	0	0	64
6	23.6	1	3	3	7	0	0	0	0	0	0	0	1	1	8
7	43.0	1	6	19 315	19 322	32	55	10	100	2 648	2 845	110	352	462	22 629
8	54.9	0	15	836	851	29	15	5	0	185	234	9	29	38	1 123
9	32.2	0	15	45	60	2	10	0	0	5	17	7	4	11	88
10	40.9	2	47	76	125	2	0	3	0	40	45	6	22	28	198
11	36.7	0	0	193	193	2	1	0	0	185	188	3	5	8	389
12	30.3	0	7	424	431	32	20	2	100	563	717	4	10	14	1 162
13	23.9	0	69	20	89	2	0	0	0	60	62	2	28	30	181
14	24.8	3	27	2	32	10	2	0	0	5	17	3	1	4	53
15	17.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	29.5	0	0	3	3	0	0	0	0	0	0	0	0	0	3
17	15.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	24.1	0	0	0	0	0	0	0	0	0	0	1	0	1	1
19	50.7	0	25	365	390	5	46	0	12	25	88	8	13	21	499
20	21.4	0	0	1	1	0	0	0	0	0	0	2	0	2	3
Total	610.9	8	390	23 133	23 531	404	189	20	604	4 772	5 989	287	605	892	30 412

Table 15.4
Principal habitats in survey sectors in Map 15.1 (Colombia-1)

Sector no.	Habitat description
1	Sand beaches grading into mudflats, mangroves / low-lying forest
2	Soft estuarine mudflats backed by mangroves / forest
3	Sand- and mudflats / palms and occasional bluffs / forest
4	Broad sand beach with mangrove swamp around river exit / forest
5	Broad sand beach / dead mangroves / low-lying forest with some ponds
6	Sandflats and occasional tough mudbanks, dead mangroves / channelled estuary with extensive mangrove forest
7	Mud- and sandflats, mangroves / estuarine forest
8	Mud- and sandflats, mangroves, river exits / forest, river channels
9	Sand beach, river exit with mudflats and mangroves / swampy forest, river channels
10	Sand beach along foreshore, extensive mudflats and mangroves in estuary / forest
11	Sand beach along foreshore, extensive mudflats and mangroves in estuary / forest
12	Sand beach along foreshore, extensive mudflats and mangroves in estuary / forest
13	Mangrove island complex with broad mudflats / sand beach along foreshore
14	Mangrove island complex with mudflats, sandy shoreline along north side of bay / forest, city
15	Narrow shore with some sand beaches / cliffs / heavy forest
16	Narrow shore with some sand beaches, flats / cliffs / heavy forest
17	Narrow shore with some sand beaches, flats / cliffs / heavy forest
18	Sand beaches / scrubby forest, some ponds
19	Sandy foreshore, estuarine mangrove island complex with mudflats / forest
20	Sand beach / grassy strip / forest

channels, islands, and mangroves behind the outer ocean beach. Overflights of some of the inner parts of the park did not reveal any extensive areas of mudflats, and it did not appear likely that any appreciable numbers of shorebirds would be found away from the coast at the stage of the tide at which the flights were conducted. The eastern sections of outer shoreline of the Sanquianga National Park, between Sectors 6 and 7, were not surveyed for logistical reasons.

The lowland coastline continued between Bahia Guapi and Bahia de Buenaventura (Sectors 7–14; Table 15.4). Sectors 7 and 8, between the Bahia Guapi and Punta Coco, contained a number of mangrove-lined bays with mud- and sandflats; a series of sandy outer points and shoreline separated the bays. North of Punta Coco, the barrier coastline resumed, consisting of long, outer, wave-washed sandy beaches and a complex of mangrove-lined estuaries and inlets behind the outer shore. Many of the inlets on this section of coast appeared to have fairly extensive areas of mudflats.

By far the largest numbers of shorebirds found on the Pacific coast of Colombia occurred in Sector 7; surveys were conducted at high tide, and large flocks of roosting birds were encountered on the sandy points and outer shorelines between the bays. The sector total of 22 600 represented 70.8% of the shorebirds counted on the Pacific coast of Colombia. The majority of the birds (85.4%) were peeps, the total of 19 300 representing 80.9% of the eco-unit total and 33.1% of the regional Pacific Coast total. Almost half of the medium-sized (45.7%) and large (46.2%) species seen on the Colombian Pacific coast were found in the sector, with a notable number of a variety of species being observed (Table 15.3). Moderate numbers of shorebirds occurred in Sector 8.

Shorebirds continued to be moderately numerous on the lowland coast between Punta Coco and Bahia de Buenaventura (Sectors 9–14), largest numbers being found in Sector 12 in the estuary of the Rio Cajambre. Sander-

Map 15.2 (Colombia-2)
Distribution of Nearctic shorebirds along the northern Pacific coast of Colombia

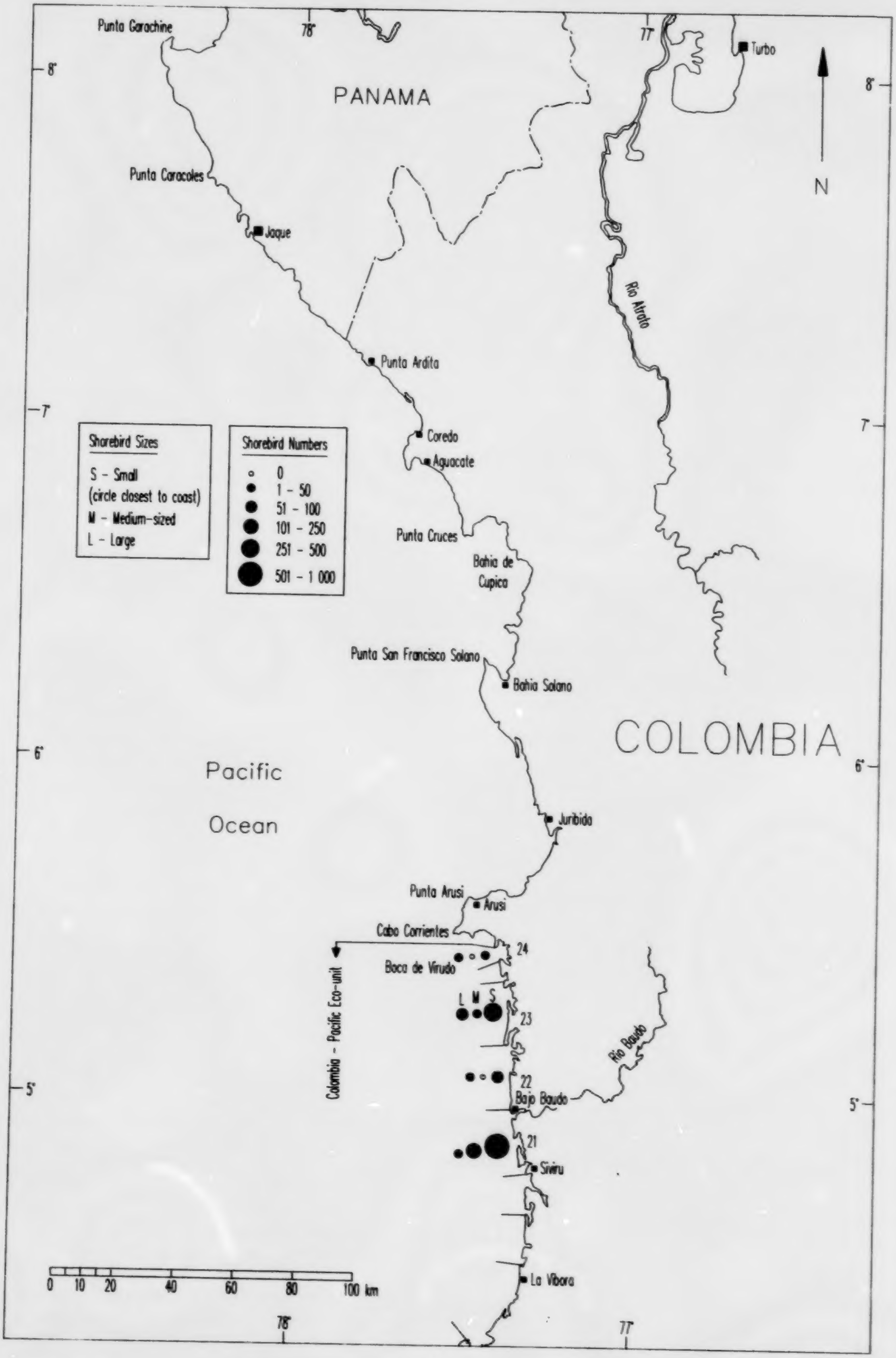

Punta Garachine
78°
77°
Turbo
8°
8°
PANAMA
N
Punta Caracoles
Jaque
Rio Atrato
Punta Ardita
7°
7°
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
○ 0
● 1 - 50
● 51 - 100
● 101 - 250
● 251 - 500
● 501 - 1 000
Coredo
Aguacate
Punta Cruces
Bahia de Cupica
Punta San Francisco Solano
Bahia Solano
COLOMBIA
6°
6°
Pacific
Ocean
Juribida
Punta Arusi
Arusi
Cabo Corrientes
24
Boca de Virudo
Colombia - Pacific Eco-unit
L
M
S
23
Rio Baudo
22
5°
5°
Bajo Baudo
21
Siviru
0
10
20
40
60
80
100 km
La Vibora
78°
77°

Table 15.5
Totals of Nearctic shorebirds in survey sectors in Map 15.2 (Colombia-2)

Sector no.	Sector length (km)	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
21	53.1	142	605	747	6	220	226	12	24	36	1 009
22	34.2	50	30	80	0	0	0	4	0	4	84
23	29.0	195	115	310	9	0	9	10	48	58	377
24	19.7	50	0	50	0	0	0	7	2	9	59
Total	136.0	437	750	1 187	15	220	235	33	74	107	1 529

Table 15.6
Principal habitats in survey sectors in Map 15.2 (Colombia-2)

Sector no.	Habitat description
21	Broad sand beach, some mangroves and mudflats around small river exits / dead mangroves behind beach, forest
22	Broad sand beach, some mangroves and mudflats around small river exits / dead mangroves behind beach, forest
23	Broad sand beach, some mangroves with broad mudflats around river exits / dead mangroves behind beach, forest
24	Bay with mangroves, some mud- and sandflats / forest

lings occurred in small numbers on the beaches of the outer coast, with peeps and other shorebirds being found on the mudflats of the bays. Relatively few birds were observed in the inner parts of Bahia de Buenaventura itself (Sector 14).

Very few shorebirds were seen along the outer coastline between Bahia de Buenaventura and the Boca Charambira (Sectors 15–18). Much of the shoreline west of Bahia de Buenaventura consisted of a low, rocky sea cliff, often heavily forested, with some small sandy beaches and bays. The relief became lower towards Sector 18, with sandy beaches backed by scrubby thickets and forests. The Bahia de Malaga was not surveyed owing to bad weather.

A somewhat narrower coastal plain extends from the delta of the Rio San Juan northwards as far as Cabo Corrientes (Sectors 19–24), with a resumption of a coastline consisting of outer sandy beaches interrupted by mangrove-lined inlets and estuaries containing mudflats. Moderate numbers of Sanderlings were found along the outer sandy beaches (460, 55.9% of the eco-unit total; Tables 15.3 and 15.5), with small to moderate numbers of a variety of other species occurring on the mudflats and around the margins of the inlets (Table 15.6). The largest concentrations on this stretch of the coast were in Sector 21 between Siviru and the mouth of the Rio Baudo.

Coastal ranges, including the Serrania del Baudo and Serrania de los Saltos, run close to the shore from Cabo Corrientes northwards to the border with Panama, producing a steep coastline with cliffs and heavily forested mountainsides. Little habitat suitable for shorebirds is thought to occur along this coast; for this and logistical reasons, the area was not surveyed.

15.4.2. Caribbean eco-unit

Sectors 25–53; Maps 15.3 (Colombia-3) and 15.4 (Colombia-4)

Shorebirds were rather patchily distributed along the Caribbean coast of Colombia. Numbers were low around the Golfo de Uraba. Moderate to small concentrations were found on the shoreline around the Rio Sinu, wetlands bordering the southern and eastern shores of the Golfo de Morrosquillo, and wetlands inland from the Bahia de Barbacoas and south of Cartagena. Some notable concentrations of peeps and dowitchers were found near Galerazamba, but the largest numbers occurred on the coast near the mouth of the Rio Magdalena near Barranquilla. No Nearctic shorebirds were seen on surveys of the inland wetlands around the Cienaga Grande east of Barranquilla. The coastline of the Guajira Peninsula could not be surveyed.

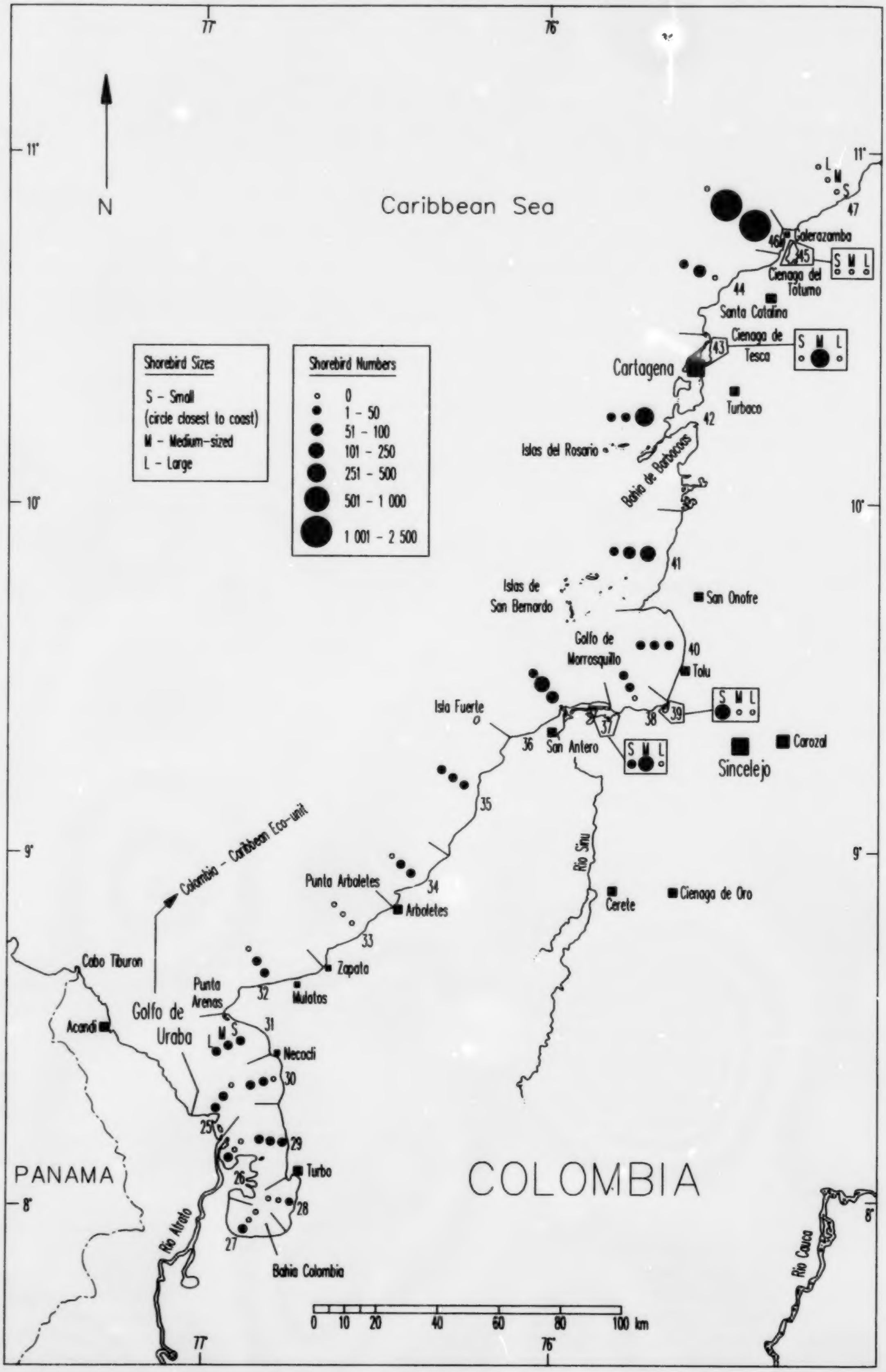
Very few shorebirds were seen around the shoreline of the Golfo de Uraba (Sectors 25–31; Table 15.7). A few shorebirds, mainly Sanderlings and peeps, were seen on the narrow, north-facing sandy beaches near the start of Sector 25. Much of the remainder of Sector 25 and most of Sector 26, comprising the delta of the Rio Atrato, contained shorelines that were heavily vegetated to the edge of the water (Table 15.8). Even though the entire area is very low-lying, the heavily vegetated shoreline and relatively small tidal ranges result in little shoreline habitat suitable for shorebirds. Narrow sandy beaches were found along some stretches of the inner gulf in Sectors 27 and 28, backed by wet grassland and/or palms, although extremely few shorebirds were noted. The east coast of the Golfo de Uraba between Turbo and Punta Arenas (Sectors 29–31) was also mostly low-lying, with a narrow sandy beach along the shore, backed by palm forests or scrubby grasslands; large, very extensive open grasslands occurred on the northern part of this stretch in Sector 31.

The shoreline of the mainland between Punta Arenas and Isla Fuerte (Sectors 32–35) continued to be generally sandy, backed by grassland or palm plantations, with sections of cliffs or hills in places. Shorebird numbers were very low throughout this area.

Moderate numbers of shorebirds were seen along the shoreline of the delta of the Rio Sinu in Sector 36, the total of 210 consisting of a variety of species (Table 15.7), including peeps (85), Black-bellied Plovers (22), Ruddy Turnstones (33), yellowlegs (10), Whimbrels (11), and Willets (3). In 1942, the Rio Sinu developed a new outlet eastwards into the Golfo de Morrosquillo (Troll and Schmidt-Kraeplin 1965), and 190 shorebirds, mostly Black-bellied Plovers (165) and Ruddy Turnstones (20), were found in the mangrove wetlands in this area (Sector 37).

Apart from the 160 peeps seen in the mangrove wetlands around the river entering the gulf south of Tolu (Sector 39), few shorebirds were seen along the remaining coastline of the Golfo de Morrosquillo (Sectors 38 and 40), which consisted mostly of sandy beaches backed by scrub.

Map 15.3 (Colombia-3)
Distribution of Nearctic shorebirds along the western Caribbean coast of Colombia



77°
76°
11°
10°
9°
8°
N
Caribbean Sea
Shorebird Sizes
S - Small
(circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
L
M
S
47
46
Galerazamba
45
S M L
Cienaga del Totumo
44
Santa Catalina
Cienaga de Tesca
43
S M L
Cartagena
Turbaco
42
Islas del Rosario
Bahia de Barbacoas
41
Islas de San Bernardo
San Onofre
Golfo de Morrosquillo
40
Tolu
S M L
39
38
37
Isla Fuerte
36
San Antero
S M L
Sincelejo
Corozal
35
Colombia - Caribbean Eco-unit
Rio Sinu
Punta Arboletes
34
Arboletes
Cerete
Cienaga de Oro
33
Cabo Tiburon
Zapata
Punta Arenas
32
Mulatos
Golfo de Uraba
Acandi
31
L M S
Necocli
30
25
29
Turbo
26
PANAMA
COLOMBIA
28
27
Rio Atrato
Bahia Colombia
Rio Cauca
0 10 20 40 60 80 100 km

Table 15.7
Totals of Nearctic shorebirds in survey sectors in Map 15.3 (Colombia-3)

Sector no.	Sector length (km)	Spotted Sandpiper	Sanderling	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Willet	Total large shorebirds	Total shorebirds
25	17.2	0	15	35	50	4	5	0	0	0	9	0	0	0	59
26	44.1	0	0	1	1	0	0	0	0	0	0	0	0	0	1
27	29.1	1	0	2	3	0	0	0	0	0	0	0	0	0	3
28	20.1	2	0	0	2	0	0	0	0	0	0	0	0	0	2
29	22.9	2	0	18	20	6	8	0	0	1	15	2	0	2	37
30	19.8	0	0	0	0	3	15	0	0	3	21	1	0	1	22
31	21.6	9	0	2	11	6	0	1	0	1	8	1	0	1	20
32	38.1	1	0	2	3	5	0	0	0	0	5	0	0	0	8
33	32.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	38.2	0	0	1	1	2	0	0	0	0	2	0	0	0	3
35	37.0	0	0	1	1	5	20	0	0	2	27	1	0	1	29
36	38.6	2	1	85	88	22	33	10	0	40	105	11	3	14	207
37	11.5	3	0	0	3	165	20	0	0	0	185	0	0	0	188
38	17.0	0	0	0	0	0	1	0	0	0	1	2	0	2	3
39	9.9	0	0	155	155	0	0	0	0	0	0	0	0	0	155
40	34.6	1	25	0	26	1	0	0	0	5	6	0	2	2	34
41	36.4	7	15	119	141	16	28	4	0	18	66	4	4	8	215
42	37.3	0	0	440	440	0	0	0	0	50	50	0	12	12	502
43	26.1	0	0	0	0	0	0	0	25	400	425	0	0	0	425
44	44.6	0	0	0	0	33	11	2	23	0	69	3	0	3	72
45	21.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	9.4	0	0	2 000	2 000	0	0	0	1 500	0	1 500	0	0	0	3 500
47	44.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	651.5	28	56	2 861	2 945	268	141	17	1 548	520	2 494	25	21	46	5 485

Table 15.8
Principal habitats in survey sectors in Map 15.3 (Colombia-3)

Sector no.	Habitat description
25	Narrow sand beach with dead tree trunks / bushy swamp
26	Narrow sand beach associated with large single-channelled river exits / bushy swamp, palm forest
27	Narrow sand beach with some spits, several small river exits / mangroves and palms / wet grassland
28	Narrow sand beach with some spits, several small river exits / mangroves and palms / wet grassland
29	Narrow sand beach / low palm forest
30	Narrow sand beach / low palm forest
31	Narrow sand beach / low palm forest, grassland
32	Broad sand beaches / palm forest, grassland
33	Narrow sand beach / some low cliffs / scrubby grassland, palm plantations
34	Sand beach with some gravelly sections / cliffs / scrubby grassland, palm plantation
35	Steep sand beaches with some bouldery sections / forested hills
36	Sand beaches with some small lagoons and river exits / palm forest, grassland
37	Mudflat and large mangrove island complex around river mouth / scrub
38	Sand beaches / scrub
39	Inland; small mangrove swamp, marshes / scrub
40	Sand beaches / scrub, habitations, small lagoons
41	Sand beaches / scrub, habitations, small lagoons
42	Inland; large mangrove swamp with extensive marshy areas / sandy ocean beach, scrub
43	Inland; lagoon surrounded with mangroves and mudflats / city
44	Wide sand beaches with small lagoons / some low cliffs / scrub
45	Inland; freshwater lake, marshy shoreline / scrubby forest, farmland
46	Sand beach with narrow brackish lagoon immediately behind / scrubby desert
47	Wide sand beaches with small lagoons near shore / some low cliffs / cliffs

Numbers of shorebirds increased slightly along the sandy beaches and small mangrove lagoons in Sector 41 (Table 15.8). Extensive mangrove complexes were found behind the shoreline of the Bahia de Barbacoas running north to Turbaco (Sector 42), and these contained moderate numbers of shorebirds, mainly peeps. Moderate numbers of medium-sized shorebirds, including dowitchers, were found in the mangrove lagoons of the Cienaga de Tesca at Cartagena.

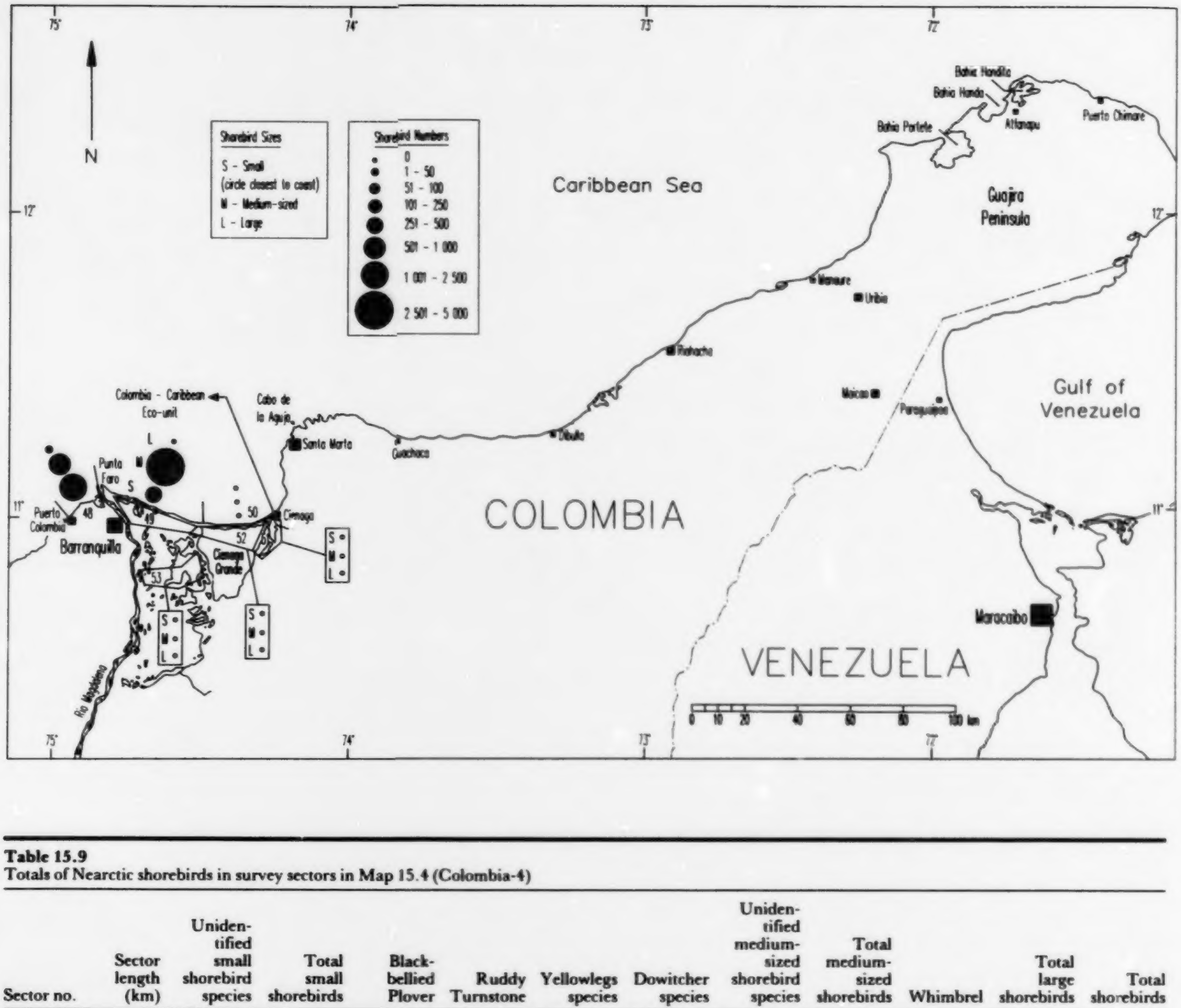
Few shorebirds were found along the outer sandy coastline between Cartagena and Puerto Colombia (Sectors 44, 45, and 47), and none in the freshwater marshes making up the Cienaga del Totumo (Sector 45). The only large concentration on this stretch occurred in a nearshore brackish lagoon near Galerazamba, where an estimated 2000 peeps and 1500 dowitchers were roosting.

The most impressive concentrations of shorebirds observed on the Caribbean coast occurred near the mouth of the Rio Magdalena in Sectors 48 and 49 (Table 15.9). Most of the birds were found in the large open lagoons situated behind the outer shoreline both to the west and to the east of the river mouth. The 5500 shorebirds counted in these areas represented 50.2% of the total on the Caribbean coast of Colombia; peeps and medium-sized shorebirds, particularly Black-bellied Plovers, were most numerous. Black-bellied Plovers used the outer sandy beaches near the river mouth as well as the lagoons.

No shorebirds were seen along the outer sandy beaches of the major barrier spit, which has been built from west to east, separating the Cienaga Grande from the Caribbean Sea (Sector 50).

Flights were made over the lagoon areas on the northeast side of the Cienaga Grande (Sector 51), the north shore of the Cienaga Grande itself (Sector 52), and the complex of lagoons to the west (Sector 53); no Nearctic shorebirds were seen, although the area supported large numbers of Neotropical species, particularly herons,

Map 15.4 (Colombia-4)
Distribution of Nearctic shorebirds along the eastern Caribbean coast of Colombia



75°
74°
73°
72°
12°
11°
N
Shorebird Sizes
S - Small (circle closest to coast)
M - Medium-sized
L - Large
Shorebird Numbers
0
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1 000
1 001 - 2 500
2 501 - 5 000
Caribbean Sea
Bahia Hondita
Bahia Honda
Bahia Portete
Puerto Chimare
Guajira Peninsula
Uribia
Riohacha
Maicao
Paraguaipoa
Gulf of Venezuela
Colombia - Caribbean Eco-unit
Cabo de la Aguja
Santa Marta
Guachaca
Dibulla
Punta Faro
Puerto Colombia
Barranquilla
Cienaga
Cienaga Grande
Rio Magdalena
48
49
50
52
53
COLOMBIA
VENEZUELA
Maracaibo
0 10 20 40 60 80 100 km

Table 15.9
Totals of Nearctic shorebirds in survey sectors in Map 15.4 (Colombia-4)

Sector no.	Sector length (km)	Unidentified small shorebird species	Total small shorebirds	Black-bellied Plover	Ruddy Turnstone	Yellowlegs species	Dowitcher species	Unidentified medium-sized shorebird species	Total medium-sized shorebirds	Whimbrel	Total large shorebirds	Total shorebirds
48	17.9	1 640	1 640	316	5	3	0	200	524	4	4	2 168
49	49.2	370	370	657	29	0	10	2 300	2 996	0	0	3 366
50	26.7	0	0	0	0	0	0	0	0	0	0	0
51	24.2	0	0	0	0	0	0	0	0	0	0	0
52	45.8	0	0	0	0	0	0	0	0	0	0	0
53	38.4	0	0	0	0	0	0	0	0	0	0	0
Total	202.2	2 010	2 010	973	34	3	10	2 500	3 520	4	4	5 534

Table 15.10
Principal habitats in survey sectors in Map 15.4 (Colombia-4)

Sector no.	Habitat description
48	Inland; large, mostly unvegetated lagoon / scrubby desert
49	Inland; lagoon complex with mangrove and muddy habitat / sand ocean beach, scrubby desert, large lake
50	Sand beach / scrubby desert, large lake
51	Inland; part of marsh and mangrove complex / sand ocean beach, scrubby desert, large brackish lake
52	Inland; strip of mangrove swamp along north side of large lake / scrub
53	Inland; complex of marsh and mangroves (many dead) associated with large lake / scrub

egrets, and cormorants. Little shoreline habitat was available for shorebirds throughout much of the area, owing to high water levels and mangroves growing to the edge of the water (Table 15.10).

The coast east of the Cienaga Grande to the border with Venezuela on the Guajira Peninsula could not be surveyed. Little shorebird habitat probably exists immediately east of Santa Marta, where the mountain ranges reach the coast, resulting in a steep, rocky, cliffed shoreline with pocket beaches. Farther east, important areas for flamingos occur in the inlets between Dibulla and Riohacha, and the series of coastal lagoons between Riohacha and Manaure is thought to be very important for shorebirds and other aquatic birds. Other potentially important shorebird areas include the lagoons on the Guajira Peninsula itself. Future surveys of these areas are needed to assess their importance for shorebirds.

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